Missouri

State Emergency Management Agency

MISSOURI STATE HAZARD MITIGATION PLAN

May 2007

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Introduction

Hazard mitigation—defined by the Federal Emergency Management Agency (FEMA) as any action taken to eliminate or reduce the long-term risk to human life and property from natural and technological hazards—is crucial to the residents of Missouri. Because Missouri is subject to many kinds of hazards, in particular tornadoes, floods, drought, earthquakes, severe winter weather, and wildfires, hazard mitigation is of great importance to the state and its residents.

Recognizing that the effects of most disasters can be lessened through proper planning and preventive measures, this Missouri State Hazard Mitigation Plan has been written to establish the means the state will use to identify cost-effective mitigation measures, including reduction and avoidance, that can be taken to reduce or eliminate the long-term risk to human life and property from natural hazards. It is the result of a systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards present in Missouri and includes those actions needed to minimize future vulnerability to those hazards.

This plan has taken into account many years of mitigation experience and a variety of mitigation projects from Missouri and other states as well. It has taken advantage of the collective mitigation knowledge of many state, federal, and local officials as well as representatives from both the public and private sectors and is designed as one component to help safeguard the residents of Missouri. As such, it should significantly contribute to the mitigation of future Missouri disasters. Without the help and coordinated assistance of many federal, state, and local officials, this program would not be the success it is in Missouri.

As a result of the disastrous flooding of 1993, the governor of Missouri, in Executive Order 93-40, expressed the need for a state policy that focused on minimizing the effects of future flood devastation. It is essential that state policy be directed to minimize the risk of future devastation and that proper management of areas in the floodplain, including development, rebuilding, and other postflood projects, requires proper attention to sound long-range policy. Subsequent flooding disasters and the continued threat of these events to the state creates significant interest in nonstructural flood hazard mitigation measures at the national, state, and local levels. However, mitigation measures must address not only flooding but other hazards as well. Therefore, this hazard mitigation plan considers all hazards that threaten the residents of Missouri. A demonstration of the state's commitment to all-hazards mitigation is the increase in the number of tornado safe room projects and the burial of electric service lines to mitigate utility outages and repair costs from severe weather events such as ice storms, high winds, and tornadoes.

This plan is designed to provide a general blueprint for hazard mitigation activities and is structured to serve as the basis for specific hazard mitigation efforts for multiple hazards. It is done so in a manner that meets federal requirements for mitigation planning and that complies with collaboratively developed national standards for emergency management. As such, it is

approved by the Federal Emergency Management Agency and conditionally accredited by the Emergency Management Accreditation Program. Updates may be required to address specific issues arising from a given hazard event or based on changes in federal or state laws and regulations. This plan underwent a significant update in 2007 as part of its three-year update cycle.

This plan identifies hazards and considers ways to reduce vulnerability to natural hazards in Missouri. It encompasses a variety of life- and property-saving hazard mitigation initiatives, including mitigation coordination, acquisition/relocation/retrofitting, floodplain management, tornado safe rooms, flood and earthquake structural projects, and technical assistance. Both short-term and long-term hazard mitigation measures are identified and prioritized to help all state and local agencies allocate mitigation resources in a responsible manner to provide for the safety, health, and general welfare of all the people in Missouri.

Organization

This plan is organized around FEMA's mitigation planning process and is divided into eight chapters, briefly summarized below:

- **Chapter 1 Prerequisite** includes the state's adoption of the plan and assurances that the state will comply with all applicable federal statutes and regulations.
- **Chapter 2 Planning Process** explains the planning process, including how it was prepared, who was involved, and how it was integrated with other related planning efforts.
- **Chapter 3 Risk Assessment** features the risk assessment, which identifies the type and location of hazards that can affect Missouri, analyzes the state's vulnerability to the hazards identified, and serves as the factual basis for the mitigation strategy.
- **Chapter 4 Comprehensive State Hazard Mitigation Program** provides the state's mitigation blueprint. Specifically, it includes goals and objectives, state and local capabilities, mitigation activities, and funding sources.
- **Chapter 5 Coordination of Local Mitigation Planning** describes the state's role in funding, developing, coordinating, and approving local mitigation plans, and how the state prioritizes funding for local mitigation plans and projects.
- **Chapter 6 Plan Maintenance** presents the method the Hazard Mitigation Planning Team uses to monitor, evaluate, and update the plan. It also introduces how the team monitors project implementation and closeouts and reviews progress on achieving goals.
- **Chapter 7 Enhanced Plan** is the "enhanced" portion of the plan and documents Missouri's project implementation capability and commitment to a comprehensive mitigation program.
- **Appendices** include supporting information for the various sections.

1.0 Prerequisites

Hazard mitigation has become an increasingly important component of disaster recovery since 1988 when the Disaster Relief Act of 1974, Public Law 93-288, was amended by Public Law 100-707, the Robert T. Stafford Disaster Relief and Emergency Assistance Act. Even greater emphasis was placed on hazard mitigation and predisaster mitigation (Section 203) with the enactment of another amendment, the Disaster Mitigation Act of 2000. This enhanced Missouri State Hazard Mitigation Plan is a direct result of this recent amendment to the Stafford Act.

Public Assistance—Mitigation

Section 406 (Public Assistance) of the Stafford Act establishes the program for the repair, restoration, and replacement of facilities damaged as a result of a presidentially declared disaster. These funds can also be used for hazard mitigation measures a state or local government determines to be necessary to meet a need for governmental services and functions in the area affected by the major disaster. Section 406 mitigation funds can only be used in the declared disaster areas (usually counties) and only in conjunction with identified, eligible disaster projects that will strengthen existing infrastructure and facilities to more effectively withstand the next disaster. One example would be replacing a blown out culvert with one designed to convey higher flows, instead of one that will be easily damaged in a flood again.

Hazard Mitigation Grant Program

Section 404 (Hazard Mitigation Grant Program) allows the federal government to contribute up to 75 percent of the cost of cost-effective hazard mitigation measures that substantially reduce the risk of future damage, hardship, loss, or suffering in any area affected by a major disaster. Such mitigation measures shall be identified following the evaluation of natural hazards under Section 322 of the Disaster Mitigation Act. Total contributions for hazard mitigation under Section 404 shall not exceed 15 percent of the estimated federal assistance (excluding any associated administrative costs) provided as a result of a presidential major disaster declaration. In fiscal year 2007, states with standard hazard mitigation plans are eligible for 15 percent for disaster assistance not more than $2 billion, 10 percent for disaster assistance of more than $2 billion and not more than $10 billion, and 7.5 percent for disaster assistance more than $10 billion and not more than $35.3 billion. Section 404 funds may be used for a variety of eligible projects that may or may not be related to the disaster and, if the state allows, in counties that were not in the declared disaster area. Project examples can range from buying out properties inundated by flooding to building a new tornado shelter for a vulnerable community.

Mitigation Planning

Section 322 (mitigation planning) establishes the requirement for a state hazard mitigation plan. To receive federal mitigation funds, states must develop and submit for approval to FEMA a

standard hazard mitigation plan that includes details of the state's natural hazards risks and vulnerabilities and mitigation goals, objectives, and priorities. Section 322 also allows the president to increase mitigation contributions to 20 percent of the federal assistance (Section 404) if the approved state hazard mitigation plan contains additional enhanced mitigation program management information. This document is Missouri's standard and enhanced state hazard mitigation plan, which was initially approved by FEMA in 2004.

1.1 Plan Adoption

Requirement §201.4(c)(6):	The plan must be formally adopted by the state prior to submittal to [FEMA] for final review and approval.

The Missouri State Hazard Mitigation Plan is the result of the systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards present in Missouri and includes the actions needed to minimize future vulnerability to those hazards. It sets forth the policies, procedures, and philosophies that will be used to establish and implement hazard mitigation activities within the state. Effective and consistent implementation of this plan is crucial to the hazard mitigation program and the state's efforts to reduce or eliminate the threat of future disasters. This plan, formally adopted May 12, 2004, incorporates all changes associated with the implementation of the federal/state hazard mitigation program, including the applicable sections of the Disaster Mitigation Act of 2000 and is in compliance with the mitigation standards for accreditation outlined in the Emergency Management Accreditation Program (EMAP).

Overall administration of the hazard mitigation program is the responsibility of the Missouri State Emergency Management Agency (SEMA) Logistics, Mitigation and Floodplain Management Branch. This branch will review the plan annually or as needed if hazard mitigation regulations or guidelines change. The plan will be updated every three years. Additionally, the plan or update will be submitted to FEMA Region VII following a presidential disaster declaration if the state's priorities change.

This 2007 update of the Missouri State Hazard Mitigation Plan was submitted to the director of SEMA, as the authorized representative of the governor, for his approval. He approved the plan and submitted a letter with his signature declaring the document to be officially adopted by the state to FEMA Region VII along with a copy of the plan on June 13, 2007. The plan was approved by FEMA Region VII on July 26, 2007.

1.2 Compliance with Federal and State Laws and Regulations

Requirement §201.4(c)(7):	The plan must include assurances that the state will comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c). The state will amend its plan whenever necessary to reflect changes in state or federal laws and statutes as required in 44 CFR 13.11(d).

General Compliance Assurance Statement

Because of inherent limitations in any grant management program, errors may occur; however, as referenced throughout this plan, it is SEMA's intent to comply with all administrative requirements outlined in 44 CFR 13 and 206 in their entirety and to monitor all subgrant supported activities to ensure compliance with 44 CFR 13 and 206 in their entirety.

44 CFR 14, Administration of Grants: Audits of State and Local Governments, requires all subgrantees receiving $500,000 or more in federal assistance to have an audit conducted in accordance with the Single Audit Act. Such reports by an independent certified public accountant will be maintained by SEMA. All general audit requirements in 44 CFR 14 will be adhered to by SEMA as well as subgrantees receiving FEMA hazard mitigation grant awards.

SEMA will amend the Missouri State Hazard Mitigation Plan whenever necessary based on changes to federal laws and regulations or changes in state laws, organizations, policies, or agency operations. Such amendments will be submitted to FEMA for approval. More about how the plan will be reviewed and updated is in Section 6.1.1 Plan Maintenance Process.

Authorities

This plan was prepared to meet, follow, comply with, and fulfill the requirements, rules, policies, procedures, and documentation required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (as amended by the Disaster Mitigation Act of 2000); all pertinent presidential directives associated with the U.S. Department of Homeland Security and FEMA; all aspects of 44 CFR (all parts and subparts, sections, paragraphs, subparagraphs, etc.) pertaining to hazard mitigation planning and grants pertaining to the mitigation of adverse effects of disasters (natural and manmade); interim final rules and final rules pertaining to hazard mitigation planning and grants, as described above; all planning criteria issued by FEMA; and all Office of Management and Budget circulars and other federal government documents, guidelines, and rules.

Specific authorities include the following:

Statutes

State

- Constitution of the State of Missouri, as amended
- Chapter 44, Emergency Management, Revised Statutes of Missouri, as amended
- Chapter 160.451-160.457, Schools—General Provisions, Earthquake Emergency Procedure, Revised Statutes of Missouri, 2003
- Chapter 256, Geology, Water Resources, and Geodetic Survey, Interstate Earthquake Emergency Compact and Geologic Hazard Assessment, Revised Statutes of Missouri, 2003
- Chapter 319, General Safety Requirements, Pipelines, Seismic Building Ordinances, Revised Statutes of Missouri, 2003

*Federal**

- Public Law 93-288, as amended by Public Law 100-707, The Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 USC 6121 et seq.)
- Public Law 93-234, Flood Disaster Protection Act of 1973
- Public Law 99-499, Superfund Amendments and Reauthorization Act of 1986
- Public Law 101-615, Hazardous Materials Transportation Uniform Safety Act
- Public Law 96-510, Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Section 104(i),(42 USC 9604(i))
- Public Law 101-549, Clean Air Amendments of 1990
- Public Law 85-256, Price-Anderson Act
- Public Law 84-99 (33 USC 701n) for flood emergencies
- Public Law 89-665 (16 USC 470 et seq.), National Historic Preservation Act
- Public Law 95-124, as amended by Public Laws 96-472 and 99-105, Earthquake Hazards Reduction Act of 1977 (42 USC 7701 and 7704)
- Public Law 90-448, National Flood Insurance Act of 1968 (42 USC 4001 et seq.)
- Public Law 107-296, Homeland Security Act of 2002
- Public Law 96-295, The Nuclear Regulatory Commission Appropriations Authorization Act
- The National Security Act of 1947

*As amended where applicable

Administrative Rules

Federal

- 44 CFR Parts 59-76, National Flood Insurance Program and related programs
- 44 CFR Part 13 (The Common Rule), Uniform Administrative Requirements for Grants and Cooperative Agreements

- 44 CFR Part 206, Federal Disaster Assistance for Disasters Declared after November 23, 1988
- 44 CFR Part 9, Floodplain Management and Protection of Wetlands
- 44 CFR Part 10, Environmental Considerations
- 44 CFR Part 14, Audits of State and Local Governments

Executive Orders

State

- 82-19, Provisions for the necessary and appropriate state coordination and participation with the Federal Insurance Administration under the National Flood Insurance Act of 1968
- 93-40, Establishes the Task Force on Flood Plain Management
- 97-09, Authorizes SEMA to issue floodplain development permits for any state owned or leased development in a special flood hazard area.

Federal

- Executive Order 11988, Floodplain Management
- Executive Order 11990, Protection of Wetlands
- Executive Order 12656, Assignment of Emergency Preparedness Responsibilities
- Executive Order 12148, Federal Emergency Management
- Executive Order 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- Homeland Security Presidential Directive 5, Management of Domestic Incidents, February 28, 2003
- Homeland Security Presidential Directive 8, National Preparedness, December 17, 2003.

Other

Emergency Management Accreditation Program

- Hazard Identification and Risk Assessment Standards 5.3.1, 5.3.2, and 5.3.3
- Hazard Mitigation Standards 5.4.1, 5.4.2, and 5.4.3

2.0 Planning Process

This chapter documents the process used to develop this plan, including how the state coordinates its efforts with other agencies and planning efforts. The chapter is divided into three parts:

- Documentation of the Planning Process
- Coordination among Agencies
- Integration with other Planning Efforts

2.1 Documentation of the Planning Process

Requirement §201.4(c)(1):	[The state plan must include] a description of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how other agencies participated.

The process established for this planning effort is based on the Disaster Mitigation Act of 2000 (DMA) planning and update requirements and FEMA's associated guidance for state hazard mitigation plans. The primary steps in the planning process were:

1) Identify the types of natural hazards that affect the state and develop a brief history of each;
2) Determine the present and future risk and vulnerability of Missouri residents to these hazards;
3) Assess the capabilities at the local, state, and federal levels to mitigate hazards and disasters;
4) Establish and prioritize the major hazard mitigation issues that should be addressed in the Missouri State Hazard Mitigation Plan; and
5) Identify goals, objectives, and actions for addressing these issues to reduce the state's vulnerability to present and future hazards.

2.1.1 Evolution of the State Hazard Mitigation Plan

The Missouri State Hazard Mitigation Plan was developed over several years. Initially, mitigation goals and objectives were developed separately by a number of entities. Over the years, these were incorporated into Missouri's original Section 409/hazard mitigation plan developed in 1994 and, subsequently, into the 2004 Missouri State Hazard Mitigation Plan. The federal and state agencies and other interested groups involved with the 1994 plan are listed in Table 2.1.

Table 2.1. Agencies and Groups Involved in Missouri State Mitigation Planning

State Agencies	Federal Agencies	Other Interested Groups
• State Emergency Management Agency • Attorney General's Office • Department of Agriculture • Department of Conservation • Department of Corrections • Department of Economic Development • Department of Health • Department of Natural Resources • Department of Public Safety • Department of Transportation • Office of Administration	• FEMA Region VII • National Oceanic and Atmospheric Administration National Weather Service • U.S. Army Corps of Engineers • U.S. Department of Agriculture Forest Service • U.S. Department of Agriculture Natural Resources Conservation Service • U.S. Department of Agriculture Rural Development Agency • U.S. Department of Commerce Economic Development Administration • U.S. Department of Housing and Urban Development • U.S. Environmental Protection Agency • U.S. Department of Transportation Federal Highway Administration • U.S. Fish and Wildlife Service • U.S. Geological Survey • U.S. Small Business Administration	• American Red Cross • Salvation Army • Missouri Association of Councils of Governments • 19 Missouri Regional Planning Commissions/ Councils of Government • Local governments • Electric cooperatives throughout the state • Special entities established by the State of Missouri • Professional organizations • Volunteer agencies • Special consortiums • Concerned citizens

The 2004 plan was also the result of the combined efforts and multiyear contributions of many entities. State agencies provided input on their own ongoing mitigation initiatives and possible sources of funding for mitigation projects. A Hazard Mitigation Planning Team (HMPT) was formed to develop the 2004 state plan. The primary responsibilities of the HMPT were to:

- Review proposed hazard mitigation projects to ensure they were in compliance with the state's mitigation priorities,
- Explore all potential sources of mitigation funding to ensure the state maximizes hazard mitigation implementation opportunities,
- Ensure proposed mitigation projects do not conflict with other state/local initiatives, and
- Participate in the development, review, and update of the Missouri State Hazard Mitigation Plan, as needed.

The HMPT included the following state agencies:

- Missouri State Emergency Management Agency
- Missouri Department of Agriculture
- Missouri Department of Conservation
- Missouri Department of Economic Development
- Missouri Department of Health
- Missouri Department of Insurance, Financial Institutions, and Professional Registration
- Missouri Department of Natural Resources
- Missouri Department of Transportation

While the agencies mentioned above represented the core of the HMPT, they were not the only contributors to the planning process. Other departments were incorporated into the team's activities as necessary. Missouri's mitigation program involves all levels of government, businesses, nonprofit organizations, and private citizens. A number of stakeholders contributed to the development of this plan over the years, including those listed below. More detailed information on the mitigation roles and responsibilities of these groups can be found in Section 4.2 State Capability Assessment.

- Task Force on Flood Plain Management
- Long-Term Recovery and Unmet Needs Groups
- Association of State Floodplain Managers
- Central United States Earthquake Consortium
- Structural Assessment and Visual Evaluation Coalition
- Missouri Seismic Safety Commission
- Local, state, and national volunteer groups
- Missouri Emergency Response Commission
- Regional Planning Commissions and Councils of Governments

Missouri employs a continuous improvement process to ensure that the state's mitigation planning and program efforts are effective. Missouri's planning and program successes to date are demonstrated throughout this document.

2.1.2 2007 Plan Update Process

Missouri initiated the planning process to update the Missouri State Hazard Mitigation Plan in September 2006. This section describes who was involved in the current planning process and how they were involved. The Missouri State Emergency Management Agency (SEMA) took the lead role in the plan update in 2007, under the direction of the Logistics, Mitigation and Floodplain Management Branch, with the branch chief as the planning lead. A planning and engineering firm was contracted, under a standing contract with the state for mitigation services, to facilitate the planning process and update the plan per the FEMA state plan update guidance. The contractor performed the more labor intensive tasks, such as completing HAZUS-MH flood

and earthquake loss estimations; rolling up, synthesizing, and analyzing information from local plans; and updating the mitigation strategy. A planner from the contracted firm spent eight months on-site at SEMA to interface with SEMA staff and HMPT members and collect information pertinent to the update process. The update process was completed in June 2007 with a FEMA review of the updated plan. Table 2.3 summarizes how each of the plan sections was reviewed and updated, per the FEMA update guidance.

Coordination with the Hazard Mitigation Planning Team

SEMA identified representatives from various state and federal agencies, based on previous involvement with state mitigation planning activities or those that have a stake in reducing hazard losses in Missouri, to participate on the HMPT. Seven more agencies were added to the planning team in 2007 to broaden the input and enhance coordination among agencies. The agencies new to the planning team in 2007 are indicated by an asterisk in the list below. Some of these agencies have become more involved with mitigation efforts or may be able to take advantage of federal mitigation funds. An example are the departments of Elementary and Secondary Education and Higher Education, both of which could be involved with or benefit from tornado or earthquake hazard mitigation projects. Invitations were emailed to them to attend the update process kickoff meeting on December 11, 2006, in Jefferson City, Missouri. All of the following agencies participated in the planning process and on the HMPT for the 2007 update of the state plan:

- Missouri State Emergency Management Agency (SEMA)
- Missouri Department of Agriculture (MDA)
- Missouri Department of Conservation (MDC)
- Missouri Department of Corrections (MODOC)
- Missouri Department of Economic Development (MDED)
- Missouri Department of Elementary and Secondary Education* (DESE)
- Missouri Department of Higher Education* (DHE)
- Missouri Department of Heath and Senior Services (DHSS)
- Missouri Department of Insurance, Financial Institutions, and Professional Registration (DIFP)
- Missouri Department of Labor and Industrial Relations* (DOLIR)
- Missouri Department of Mental Health* (DMH)
- Missouri Department of Natural Resources (MDNR)
- Missouri Department of Natural Resources Division of Geology and Land Survey (DGLS)
- Missouri Department of Social Services* (DSS)
- Missouri Department of Transportation (MDOT)
- Missouri Office of Administration* (MOA)
- Missouri Public Service Commission* (MOPSC)
- Missouri State Highway Patrol (MSHP)
- U.S. Army National Guard (MONG)

* New participant in 2007

Participation of the state agencies was defined early in the process. The invite letter defined participation based on the guidance in the 2004 plan, which was, at a minimum:

- Review of hazard mitigation projects and initiatives to ensure there were no potential conflicts with ongoing agency initiatives,
- Review of hazard mitigation projects and initiatives to ensure they complement the statewide mitigation strategy, and
- Review of existing state/federal programs to ensure that the state takes full advantage of possible funding sources in implementing the state hazard mitigation program.

Further guidance on participation was provided at the planning kickoff meeting as along with copies of the 2004 plan (on CD-ROM). The guidance included a schedule of activities, key meetings, and deadlines. Specific guidance was provided on what was needed for the update of Sections 3, 4 , 6, and 7. Additional guidance also asked HMPT members to:

- Participate in planning team development of new projects or initiatives,
- Record and update the status of mitigation projects your agency is involved with, and
- Review what their entity has responsibility for and change as necessary.

Instructions included guidance to send all materials and comments to the on-site planner at SEMA.

At the kickoff meeting, the planning team discussed the purpose and requirements of the state plan update, the project's scope of work and schedule, and the responsibilities of the HMPT. Three additional meetings of the HMPT were held after the kickoff meeting. Table 2.2 lists the dates and purposes of the HMPT meetings during the 2007 update planning process. SEMA sent invitations for all HMPT meetings by email. Agendas, sign-in sheets, and other meeting hand-outs are available from SEMA upon request.

Table 2.2. Meetings of the HMPT during the 2007 Plan Update Process

Meeting	Date	Meeting Purpose	Agencies Represented
1) Kickoff	12/11/2006	• Review Disaster Mitigation Act planning requirements, scope of work, and project schedule • Review role of HMPT • Discuss risk assessment data collection needs	DOLIR, DNR, DIFP, MDC, MOPSC, MONG, DSS, SEMA
2) Risk Assessment	01/31/2007	• Review and comment on draft of updated risk assessment portion of plan • Introduce methodology for capability assessment update	DNR, MDA, DHSS, DGLS, DHE, DOLIR, SEMA,
3) Goals and Measures	02/22/2007	• Discuss update to goals and objectives • Review and approve state mitigation criteria for evaluation and prioritization • Discuss update to mitigation actions and new actions	DHE, DOLIR, SEMA
4) Final Draft and Closure	04/23/2007	• Present Final Draft to HMPT and bring closure to the project	MDC, DHSS, DIFP, SEMA

During the plan update in 2007, the state experienced two presidential disaster declarations. This resulted in meetings number 1 and 3 being rescheduled and state agency staff being tied up. Some of these agency representatives provided feedback and input while on-site at SEMA during disaster operations. Personal interviews were conducted with the HMPT agency representatives that were not able to attend the meetings. These interviews were conducted by the contracted on-site planner at SEMA. The purpose of these interviews was to keep the participants informed of the progress of the plan update and to solicit information requests and obtain feedback, ensuring that all HMPT members met the participation requirements.

In addition, other personal interviews and outreach were conducted with the following stakeholders or groups to collect data, solicit input and feedback on the risk assessment update, and better understand current mitigation issues and priorities:

- Missouri state geologist and assistant state geologist
- SEMA Earthquake Program manager
- SEMA Planning and Disaster Recovery Branch chief
- Missouri Emergency Response Commission executive director
- Missouri Department of Natural Resources GIS staff
- Task Force on Flood Plain Management
- Missouri Water Resources Interdepartmental Coordination Council for Water Quality
- Missouri Rural Electric Cooperatives
- Mid America Earthquake Center
- Missouri Association of Councils of Governments

Each agency and stakeholder was engaged and contributed to the planning process. Some examples of these contributions include input, review, and comment on a new hazard profile

regarding land subsidence from the Division of Geology and Land Survey (DGLS); review and comments on the earthquake hazard profile by DGLS; comments and feedback on initial results of HAZUS-MH flood and earthquake analyses by SEMA Earthquake Program manager and SEMA Planning and Disaster Recovery Branch chief; input from various agencies at planning team meetings; direct response from multiple agencies to emails, and phone requests for information related to the process. The results are incorporated throughout this plan as appropriate. The Rural Electric Cooperatives input and review was sought due to their experiences with recent ice storm disasters, and the Mid America Earthquake Center independently reviewed and commented on a HAZUS-MH earthquake analysis.

Plan Section Review and Analysis

In the 2007 update planning process, the state updated each of the sections of the previously approved plan, including improving organization and formatting of the plan's contents. Each section was analyzed using FEMA's state plan update guidance to ensure that the plan meets requirements. Also considered were the Emergency Management Accreditation Program standards for mitigation.

SEMA reviewed each section of the plan and presented parts of Chapter 3.0 Risk Assessment and Chapter 4.0 Comprehensive State Hazard Mitigation Program to the HMPT at meetings two and three for input and ideas. Once a complete first draft of the updated plan was available, SEMA reviewed and revised it. The resulting second draft was distributed via CD-ROM to the HMPT for their review and comments. Team members were given a set time period to provide input. Feedback was received in the form of emailed comments, written comments on the draft, or documents with information relative to the plan or the appropriate agency's section. Feedback was collected and reviewed by the planning contractor and SEMA and incorporated into the plan, as appropriate, to create a third draft for state adoption, which was then submitted to FEMA Region VII for review and approval.

During the plan review, it was determined that every section required updating and revising to meet the FEMA state plan update guidance or to change information that was no longer current. Table 2.3 briefly summarizes how each section of the plan was reviewed and analyzed to reflect changes that occurred since the previous plan was approved. More detailed documentation on update methodology and process is provided at the beginning of each plan section.

Table 2.3. Summary of Update Review and Analysis of Each Plan Section

Plan Section	Update Review and Analysis
1.0–1.2 Introduction	• Updated language to describe purpose and requirements of the Missouri State Hazard Mitigation Plan update process
2.0–2.3 Planning Process	• Described planning process for 2007 update, including coordination among agencies and integration with other planning efforts
3.0 Risk Assessment	• Provided draft of the updated risk assessment to HMPT members by email for review prior to second HMPT meeting on January 31, 2007

Plan Section	Update Review and Analysis
	• Comments from the HMPT were collected at this meeting and by email and incorporated into the risk assessment
3.1–3.2 Hazard Analysis	• Included state Hazard Analysis in Sections 3.1 Identifying Hazards and 3.2 Profiling Hazards. SEMA's Planning and Disaster Recovery Branch updates the Hazard Analysis each October based on the hazard events and disaster declarations from the previous year
3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction	• Used HAZUS-MH models to update estimated losses from earthquakes and modeled flood hazards for every county • Used a statistical risk assessment methodology to update estimated losses from tornadoes for every county • Reviewed risk assessments from local plans to summarize how local governments ranked hazards in their jurisdictions and the potential losses associated with the hazards of greatest concern • Described changes in growth and development and examined these changes in the context of hazard-prone areas and how the changes affect loss estimates and vulnerability
3.4 Estimating Potential Losses of State Facilities	• Analyzed county and state bridges in Missouri subject to flood scour by using GIS and data from the National Inventory of Bridges • Determined potential losses of state facilities from the previously approved plan remain valid • Analyzed state facilities database for possible inclusion in the plan
4.0 Mitigation Strategy	• Updated 4.0 based on the results of the updated risk assessment, data from the local plans, completed mitigation actions, and implementation obstacles and opportunities over the last three years
4.1 Goals and Objectives	• Reviewed goals and objectives from the last plan and concluded that they were still representative of the state's mitigation strategy • Presented goals and objectives to the HMPT on February 22, 2007, for input and ideas
4.2 State Capability Assessment	• Improved section to include more information on state capabilities, both pre- and postdisaster, and how these capabilities have changed since the previously approved plan • Discussed changes in state funding capability and the state's policies addressing development in hazard-prone areas
4.3 Local Capability Assessment	• Reviewed capability assessments in local plans to develop a general description of local capabilities • Analyzed effectiveness of local capabilities based on local evaluations • Identified obstacles and opportunities to improving local capabilities
4.4 Mitigation Actions	• Reviewed mitigation actions from the last plan and determined they all remain current • Documented progress of actions since the previously approved plan and identified new actions • Presented mitigation actions at HMPT meeting on February 22, 2007, for input and ideas • Developed an implementation strategy action plan
4.5 Funding Sources	• Identified funding sources used since previously approved plan • Updated primary funding sources with more detail and updated list of other potential funding sources (see Appendix A Funding and Assistance Programs)

Plan Section	Update Review and Analysis
5.0 Coordination of Local Mitigation Planning	• Reviewed process for and progress in coordinating local mitigation planning • Updated information on the status of local plan completion
5.1 Local Funding and Technical Assistance	• Described how the state provided planning and technical assistance to local governments over the last three years • Updated the process for providing local assistance to focus resources on the local plan update process • Summarized current status of counties with completed and approved local plans, those in process, and those without plans
5.2 Local Plan Integration	• Described how local risk assessments, goals and objectives, mitigation actions, and capabilities were integrated into the updated state plan • Assessed the challenges and success of this integration
5.3 Prioritizing Local Assistance	• Reviewed criteria for prioritizing communities and local jurisdictions that would receive planning and project grants and determined it should remain the same
6.0–6.3 Plan Maintenance Process	• Reviewed procedures for monitoring, evaluating, and updating the plan and determined that no changes were needed • Updated system for monitoring progress of mitigation activities by identifying additional criteria
7.0–7.4 Enhanced Plan	• Reviewed and revised sections based on FEMA's guidance for enhanced plan updates • Improved integration of enhanced plan information with other sections of the plan

2.2 Coordination among Agencies

Requirement §201.4(b):	The [state] mitigation planning process should include coordination with other state agencies, appropriate federal agencies, and interested groups.

The state recognizes the importance of coordinating with local, state, and federal agencies and other interested groups involved in hazard mitigation in the planning process for the update of the Missouri State Hazard Mitigation Plan to enhance data collection, mitigation strategy development, plan implementation, and overall investment in Missouri's mitigation program. For the 2004 and 2007 planning efforts, the state involved other agencies through the Hazard Mitigation Planning Team (HMPT), the Regional Planning Commissions (RPCs), and personal interviews with key stakeholders. This approach was determined to be effective in 2004, thus it was repeated in 2007. One addition to the process in 2007 included the introduction of the Emergency Management Accreditation Program mitigation standards to the other agencies on the team so that they understand their role in meeting and upholding the standards.

As the agency designated by the Missouri governor to coordinate statewide emergency preparedness, response, recovery, and hazard mitigation activities, the SEMA works with other state, federal, and local agencies to develop and implement the strategies outlined in this document, obtain interagency feedback on the mitigation steps taken, and use that information to update this plan. SEMA acted as the coordinator of and participant on the HMPT during the planning process for the previously approved plan and for the 2007 update.

The previous section, Section 2.1 Documentation of Planning Process, listed the agencies invited to participate on the HMPT for the 2007 plan update. Members of the HMPT participated in the update process by attending planning meetings, providing data and information, and commenting on the draft version of the plan. Comments from previous reviews of the 2004 plan from FEMA Region VII and FEMA headquarters were incorporated into this update.

Other interested groups involved in the recent planning process are also listed in Section 2.1. These included the Missouri Association of Council of Governments (the RPCs) and the Task Force on Flood Plain Management. SEMA attended meetings with these groups to update them on the planning process.

As hazard mitigation planning continuously involves multiple government agencies, private voluntary organizations, and commerce and industry, it is assumed the role of other entities in updating this plan will increase over time. This plan will be adjusted accordingly to reflect new participants and their roles during the next review process. The coordination among agencies did not change between the 2004 plan and the 2007 plan update.

2.3 Integration with Other Planning Efforts

Requirement §201.4(b):	[The state mitigation planning process] should be integrated to the extent possible with other ongoing state planning efforts as well as other FEMA mitigation programs and initiatives.

The State of Missouri is fully committed to an effective and comprehensive mitigation program. Missouri is somewhat unique in that the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, Pre-Disaster Mitigation program, floodplain management, Earthquake Program, and mitigation planning are all the direct responsibility of SEMA. In order for these programs to achieve their full potential, state activities should complement appropriate mitigation goals and strategies. The best way to accomplish this is to ensure that mitigation goals and initiatives are integrated to the extent possible into all possible planning activities for federal, state, and local governments. Over the years, the works of these various entities have been incorporated into the Missouri State Hazard Mitigation Plan as well as planning activities of other state agencies.

Mitigation is considered, to the extent possible by Missouri statutes, in the earthquake plans of the Departments of Transportation; Insurance, Financial Institutions, and Professional Registration; Corrections; Natural Resources; and Education; the Office of Administration; the Public Service Commission; Missouri Seismic Safety Commission; Missouri Emergency Response Commission; and others. The Department of Transportation considers mitigation, especially floodplain management and open-space issues, in their transportation plans. The Department of Conservation has partnered with SEMA in developing streambank stabilization planning to help mitigate flooding problems in communities such as Piedmont, Missouri.

2.3.1 Integration of Local Plans

SEMA is the primary state coordinating agency for all local hazard mitigation plans. The Logistics, Mitigation and Floodplain Management Branch is responsible for working with local governments to develop, review, and update local hazard mitigation plans and integrate them with the state plan. As of February 2007, 94 of 115 Missouri counties (including St. Louis City), which accounts for 94 percent of Missouri's population, had hazard mitigation plans that meet the requirements of both the Disaster Mitigation Act of 2000 and the Flood Mitigation Assistance Program.

It is understood by all levels of government that the success of the Missouri mitigation program depends on the degree to which everyone works together toward the common goal of reducing future disaster losses in Missouri. It is also widely acknowledged that the local plans can benefit from data in the state plan, and the state plan can benefit from data in local plans. For this plan update, the HMPT reviewed, summarized, and incorporated information from the local plans. This information included hazard identification and risk assessment, goals and objectives, local capabilities, and mitigation initiatives. More information about the integration of local plans is in Section 5.2 Local Plan Integration.

2.3.2 Integrating Planning Information with Other Mitigation Partners

The Missouri State Hazard Mitigation Plan identifies Missouri's hazards, risks, vulnerabilities, goals, objectives, priorities, and strategies for mitigation. The plan is the basic document that SEMA uses to focus efforts to improve the lives of Missouri residents. Over the years, SEMA has worked continuously to identify partners (federal, state, local, and business) interested in participating in the state's mitigation efforts.

Integration of federal, state, and local agencies; business and industry; and private nonprofit organizations into the state mitigation program has been an ongoing process that has helped educate these agencies and organizations about the importance of mitigation. This educational process also has resulted in use of mitigation in their programs and plans over time. These discussions and/or meetings have involved reviews of current programs and policies that promote or could potentially promote mitigation initiatives throughout the state and reviews of existing and proposed plans to identify mitigation opportunities. Many of the mitigation successes since the 1993 floods have been as a direct result of these meetings. The lessons

learned through these programs and activities have contributed to the development of this plan and have been integrated into their own plans and programs.

This Missouri State Hazard Mitigation Plan is available to all state agencies to reference when seeking information and guidance on state mitigation goals and objectives.

SEMA also works to implement the components of this plan by being a part of the HMPT and working with the state agencies that participate on the Missouri Seismic Safety Commission, state agencies that help develop mitigation measures associated with Public Assistance projects, and state educational institutions that participate in the mitigation program.

In addition to working with FEMA in all aspects of hazard mitigation projects and plans, SEMA has worked with multiple other federal mitigation partners to integrate mitigation into projects and plans. The Natural Resources Conservation Service (NRCS) and U.S. Army Corps of Engineers provided input and advice on several mitigation initiatives in the state regarding retention/detention basins.

The successful combination of SEMA buyout and NRCS retention basins in the City of Neosho, a Project Impact Community, are an excellent example of the NRCS' support. An NRCS feasibility study led the City of Piedmont to develop several flood buyout programs to mitigate flooding over time and Project Impact Disaster Resistant Community status. Piedmont has also worked with the Missouri Department of Conservation to reduce flooding through creek cleanup and streambank stabilization activities and plans. In addition, Piedmont and the City of Maryville worked with the Economic Development Agency, using SEMA's hazard mitigation planning process, to develop communitywide business plans for disaster survivability. The City of Hannibal (another Project Impact community) followed Piedmont's creek cleanup lead and conducted similar activities.

SEMA has supported efforts to reduce damages from storms, such as the project undertaken by the City of Independence to bury electric service lines to homes that were damaged by the severe Ice Storm of 2002. SEMA's work with the City of Bolivar (a Project Impact community) helped the city procure and issue NOAA weather warning radios to local schools, nursing homes, day care centers, and college dormitories.

Around 591 Missouri communities participate in the National Flood Insurance Program (NFIP) and two participate in the Community Rating System (CRS). The SEMA Floodplain Management Section of the Logistics, Mitigation and Floodplain Management Branch conducts approximately 20 workshops each year promoting the NFIP to nonparticipating communities. Additional workshops are conducted to promote the CRS. These workshops have been instrumental in increasing the number of communities participating in both of these programs.

The National Weather Service (NWS), the electric cooperatives, and private businesses combined their resources to support the coverage expansion of the state's weather radio

transmitters. In four years, this project expanded weather radio coverage to include almost the entire state.

SEMA supports the NWS StormReady program and its many mitigation measures in Missouri. As of March 2007, Missouri had 16 counties, 25 communities, 1 industrial site, and 1 university that were recognized as StormReady.

The Missouri Department of Economic Development's Community Development Block Grant Program (CDBG) has complemented the SEMA buyout program in removing homes and businesses from the flood hazard areas throughout the state. The SEMA program has concentrated on primary family residences, while the CDBG program has included businesses and some residences. Together, these programs have made a significant impact on the overall vulnerability of individuals to flooding.

Other partners and projects include the following:

- The U.S. Army Corps of Engineers has worked with SEMA on several levee projects and requests for channelization projects.
- The Missouri Department of Conservation has worked with SEMA on endangered species and fish and wildlife management issues associated with flood buyouts and water management and conservation questions.
- The Missouri Department of Agriculture works with SEMA on agriculture and drought issues and planning, including ways to mitigate damage.
- The Missouri Department of Insurance, Financial Institutions, and Professional Registration supports SEMA in promoting flood and earthquake insurance, preparedness, response, and mitigation issues and plans.
- The Missouri Department of Natural Resources (DNR) has worked with SEMA on flood buyouts, hazardous material planning, earthquake mitigation, and dam safety plans and issues.
- The Missouri Department of Transportation, the U.S. Department of Transportation, and the Federal Highway Administration have worked with SEMA on flood buyouts, open-space restriction issues, and earthquake planning and bridge retrofits.
- In addition to the state and federal transportation agencies, the U.S. Geological Survey; Central U.S. Earthquake Consortium; DNR; Missouri Department of Insurance, Financial Institutions, and Professional Registration; Missouri Seismic Safety Commission; Missouri Structural Assessment and Visual Evaluation (SAVE) Coalition (members include the American Council of Engineering Companies/Missouri, American Institute of Architects/Missouri, American Society of Civil Engineers, Missouri Society of Professional Engineers, Structural Engineers Association of Kansas and Missouri, University of Missouri–Rolla School of Civil Engineering and Natural Hazards Mitigation Institute, Saint Louis University Earthquake Center, Washington University, Southern Illinois University–Edwardsville, University of Memphis Center for Earthquake Research and Information, and Earthquake Engineering Research Institute New Madrid Chapter) work with SEMA on

earthquake mitigation, including retrofits, public education, soil mapping, and seismic studies.
- Several Missouri businesses and business associations have worked with SEMA and local communities on disaster mitigation and business continuity planning.
- SEMA's statewide volunteer coordinator has worked for years to educate local, state, and national voluntary organizations through the Disaster Recovery Partnership, Community Organizations Active in Disaster, and the Missouri Voluntary Organizations Active in Disaster about the importance of mitigation.
- SEMA's staff served on the state Red Cross mitigation committee.

SEMA has identified many instances where the information contained in this Missouri State Hazard Mitigation Plan could be and has been integrated into the planning of state and federal departments, local governments, universities, businesses, and private associations. In 2005, SEMA sent five CDs to all Missouri mayors, emergency management departments, and public and private school superintendents that contained information about safe rooms, the Community Rating System, and floodplain management tools. SEMA invites all interested entities to freely use the information in this plan and other SEMA resources (e.g., publications, web sites, etc.) to develop and manage their plans and programs. Free copies of this plan on CD may be requested from SEMA for planning, program management, and public education purposes by calling the Logistics, Mitigation and Floodplain Management Branch at (573) 526-9228.

The general information in this plan is intended for use by interested local governments, universities, businesses, and private associations, in addition to state and federal departments and agencies.

2.3.3 Challenges in Planning Integration

This 2007 update reflects the successful integration of 82 percent of the county-level plans, which equates to coverage for 94 percent of Missouri's population. Since Missouri has 115 counties (including St. Louis City) and 948 incorporated cities, towns, and villages, SEMA was challenged with how to effectively and efficiently develop plans for each of the jurisdictions. SEMA streamlined the process by encouraging local governments to participate in multijurisdictional county-level plans, which cut down on the number of plans that needed to be reviewed and integrated and brings communities together to focus on mitigation. SEMA is trying to obtain budget to hire a new mitigation planner in mid-2007 to work with local plans on a regular basis.

By providing local mitigation planning guidance detailing form and content requirements, SEMA had hoped to further streamline the integration of local plan data into the state plan. While it did prove to be a successful tool (as evidenced by the high number of plans approved), local risk assessments used different methods and interpretations to determine vulnerability and different measures to assess risk. Therefore, it was challenging to compare the counties to see where one might be more vulnerable to a particular hazard than another. (More information

about the challenges of the local risk assessment integration can be found in Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction, Section 4.1 Hazard Mitigation Goals and Objectives, Section 4.3 Local Capability Assessment, and Section 4.4 Mitigation Actions.)

Another challenge or obstacle to integrating this plan with other planning initiatives and efforts identified during the 2007 update process was the timing of disasters during the planning process. Missouri experienced a major ice storm and flood while this plan was in the process of being updated, and both resulted in presidential disaster declarations. This impacted the availability of state agency staff to participate and contribute in HMPT meetings, as they were busy with the disaster recovery efforts. Those agencies that could not be represented at meetings were followed up with by the SEMA on-site planner to obtain necessary information and receive comments on the draft plan, but the downside of this was less face-to-face HMPT interaction. In future updates, it is recommended that the update process begin nine months or more before the update is due to ensure enough time for participation.

More information on integration with other planning efforts can be found in Section 4.3 State Capability Assessment; Section 4.4 Mitigation Actions, Table 4.9. Analysis of Considerations Used Daily in Fulfilling the State Mitigation Strategy; and Section 5.2 Local Plan Integration.

3.0 Risk Assessment

Note: The introduction to this chapter as well as Sections 3.1 Identifying Hazards and 3.2 Profiling Hazards come from the state's Hazard Analysis, which was developed by SEMA's Planning and Disaster Recovery Branch and is updated each October. Minor modifications were made to the text for the purposes of this mitigation plan. The Hazard Analysis was created to meet multiple objectives and provide direction in hazard mitigation and disaster response for the state and local emergency operations plans and hazard mitigation plans.

Lately, disasters appear to be occurring more frequently than during previous years. Federal, state, and local emergency managers need to prepare for, respond to, and recover from the increasing frequency and scope of disasters. While recent major disasters are memorable, the increased rate of occurrence is remarkable. Disasters in the 1990s were nearly twice as frequent as disasters in the 1980s. From 1993 through 2006 alone, Missouri experienced 13 presidentially declared flood disasters, including one that exceeded the once-in-every-500-years flood levels. According to some weather forecasters, the country has entered a period of extremely destructive weather patterns.

Also, the emergency management community now faces threats in many ways different than past threats. Gone are the days when emergency management was only for natural disasters and nuclear preparedness. We now face more technologically and politically based hazards that demand the attention of the emergency management community. These new hazards include a number of threats that have not been adequately dealt with in the past, including hazardous materials releases, civil disorders, and terrorism.

This document has been compiled to identify the multiplicity of hazards that exist at varying locations and degrees of magnitude throughout the state and to determine the potential impacts of these hazards on residents, property, and the environment. The information contained herein identifies capabilities essential to disaster response, for determining the probable effectiveness of allocating resources in emergency situations, and for encouraging the cooperation of various political subdivisions and emergency services in formulating regulations, plans, and programs to prepare for disasters and minimize loss of life, human suffering, and damage to public and private property. In addition, a thorough hazard analysis provides a foundation for educating senior government officials and the public on dangers posed by various hazards.

The foundation for emergency preparedness is planning how to handle disasters. The art of perfecting how to respond to disasters is enhanced by the ability to bring together the key players for periodic exercises that emulate actual disasters.

This Hazard Analysis provides a basis for activities proposed during the state's planning efforts and should be used by state and local officials to plan and prioritize resource allocations. Local officials can use information in this document to develop their own localized hazard analysis.

3.1 Identifying Hazards

Requirement §201.4(c)(2)(i):	[The state risk assessment shall include an] overview of the type…of all natural hazards that can affect the state.

Because Missouri is located in the middle section of the United States, it is prone to several kinds of natural hazards. Missouri has a continental climate; in other words, the weather is changeable and has large variations in temperature and precipitation.

Missouri serves as a major thoroughfare for transportation and has an abundant share of industrial, agricultural, and recreational facilities. Thus, manmade disasters can occur, such as hazardous materials releases, fixed nuclear facility incidents, and other emergencies caused by human action.

Missouri has four topographically distinct regions: glaciated plains in the north, plains or prairie in the west, lowlands in the extreme southeast, and the Missouri Ozarks in between.

The plains section, both glaciated and unglaciated, encompasses nearly all the area north of the Missouri River and a large area south of the river in the western part of the state. The topography varies from rolling hills in the east to hills in the west that average about 450 feet above sea level. There are numerous wide, flat valleys cut by the river.

The Ozarks, which comprise about half of the state, are characterized by rugged areas of sharp ridges and deep narrow valleys. Elevations range from about 1,000 to more than 1,600 feet above sea level.

The southeastern lowlands cover about 3,000 square miles, with elevations from 230 to 300 feet above sea level. Much of the region is excellent farmland, channeled by an extensive system of drainage ditches.

Because the state is situated along two of the continent's greatest rivers, the Missouri and the Mississippi, the potential for great floods is high. While six large flood control dams have been built on the main stream of the Missouri River, they have not eliminated the flood threat.

Warm and cool air masses often collide along sharply divided fronts, accompanied by violent thunderstorms having intense rains, strong winds, hail, lightning, and occasional tornadoes. These frontal storm systems can pass across the state at any time of the year, but are most frequent during the spring months (March, April, and May). There are two important truths about Missouri's weather: (1) the state is subject to weather extremes, and (2) extreme weather changes can occur rather quickly.

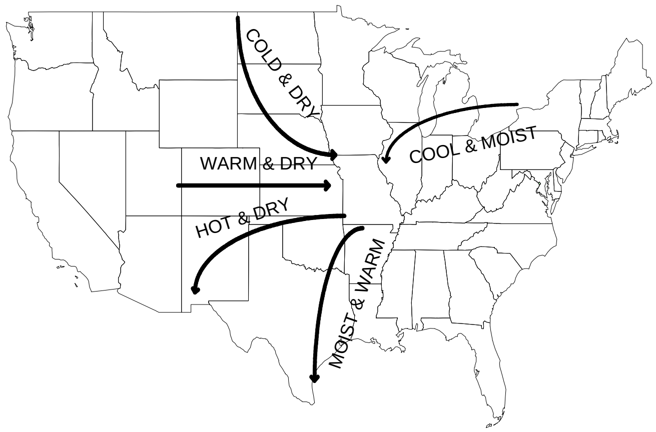
Most of the natural disasters that occur in Missouri (except for earthquakes, land subsidence, and possibly dam failures) result from a weather extreme or an extreme weather change. Because Missouri is situated in the center of the United States, it is subject to many different influences that determine weather patterns.

According to Dr. Grant Darkow,[1] Department of Atmospheric Science at the University of Missouri-Columbia, specific recognizable weather patterns are responsible for Missouri's weather, especially those that "tend to produce extremes in precipitation, resulting in unusually wet or drought conditions, and extremes in temperature, either abnormally warm or cold." Darkow explains:

> The character of air over Missouri on any particular day or series of days is dominated by the source regions from which it comes. Missouri's mid-continental location makes it subject to air flows from a variety of source regions with markedly different properties.
>
> The state is close enough to the Gulf of Mexico that warm air with high humidity can flow into the state from a southerly direction at almost any time of the year. This warm, moist air is the principal source of spring, summer, and fall precipitation and, occasionally, precipitation in winter as well.
>
> In contrast, air arriving over Missouri from semi-arid to arid regions to the southwest is warm or hot and usually dry. Air that has moved from west to east over the Rocky Mountains arrives warm and dry, having lost most of its low-level moisture as it climbed the west side of the mountains.
>
> Abnormally cold air in the winter and cold summer air with only very small moisture content arrives over Missouri from the northwest or north, whereas air entering Missouri from the northeast will tend to be cool and moist (see Figure 3.1).

[1] Grant L. Darkow, *Missouri Weather Patterns and Their Impact on Agriculture,* University Extension, University of Missouri-Columbia.

Figure 3.1. Source Regions and Atmospheric Characteristics for Air Arriving in Missouri



Darkow goes on to explain:

> Normally, the flow from one of the principal source regions will last for two or three days before switching to a different direction and source region. These transitions typically are accompanied by a frontal passage during which the change in wind direction, temperature, and moisture content, or any combination, is concentrated.
>
> In some instances, however, a particular flow pattern may be very persistent or dominant for a period of weeks or even months. These periods can lead to wet, dry, hot, or cold spells, and the extremes associated with these periods. These periods are characterized by particular upper air flow patterns and associated surface weather patterns (see Figures 3.2a, 3.2b, 3.3a, 3.3b, 3.4a, and 3.4b).

Figure 3.2a. Upper Air Pattern

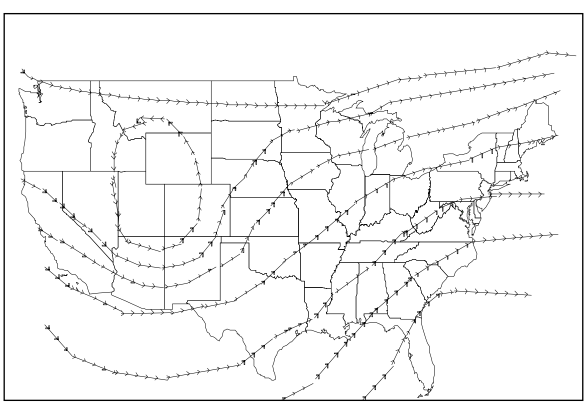


Figure 3.2b. Surface Air Pattern

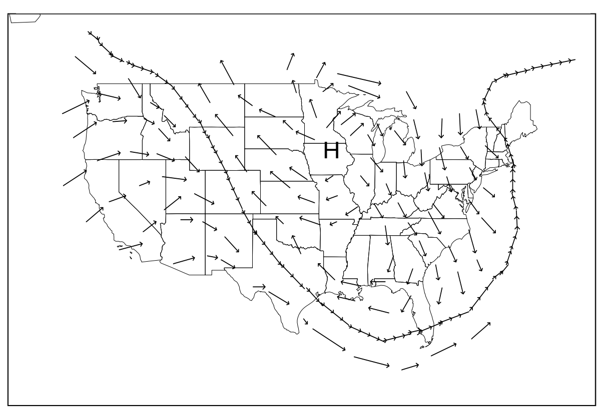


Figure 3.3a. Upper Air Pattern

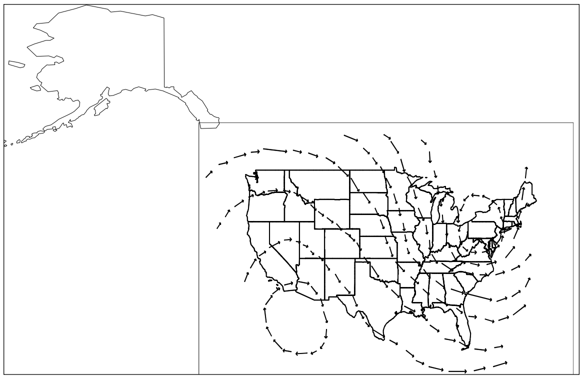


Figure 3.3b. Surface Air Pattern

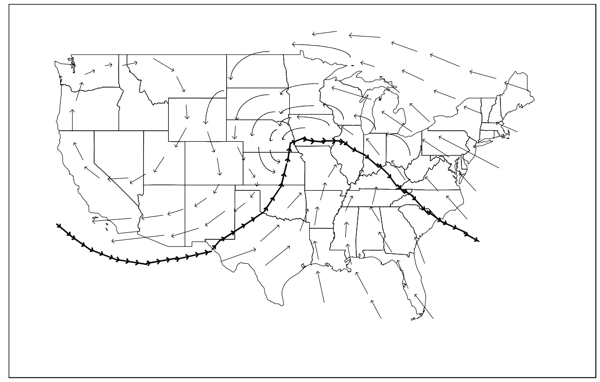


Figure 3.4a. Upper Air Pattern

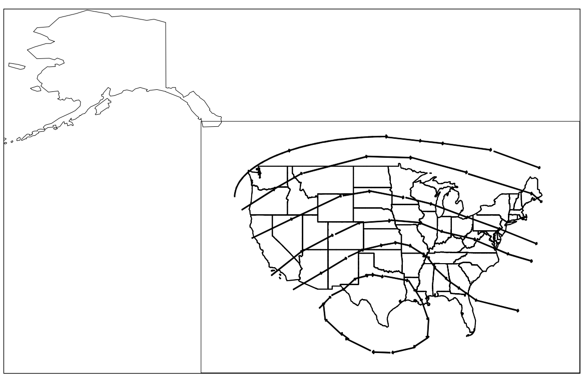
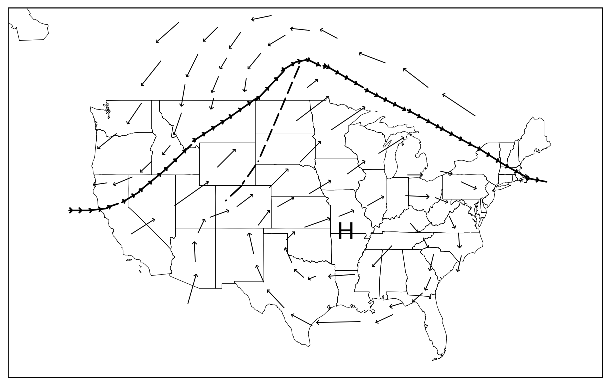


Figure 3.4b. Surface Air Pattern



> The persistence of these weather patterns and the possible resulting condition is the subject of several of the natural disasters discussed in this study. Specifically, floods, droughts, fires, heat waves, severe cold, and winter storms can be the result of the persistence of one of these weather patterns, whereas tornadoes can represent the outgrowth of rapid shifts in weather patterns. Knowing these patterns may assist in alerting disaster planners and the general public to the possibility of a developing emergency situation.

The Missouri State Emergency Operations Plan (2005) and Missouri State Hazard Mitigation Plan consider natural, manmade, and other hazards.

Natural Hazards

Natural hazards can be complex, occurring with a wide range of intensities. Some events are instantaneous and offer no window of warning, such as earthquakes. Some offer a short window in which to alert the public to take actions, such as tornadoes or severe thunderstorms. Others occur less frequently and are typically more expansive, with some warning time to allow the public time to prepare, such as flooding. The following natural hazards threaten Missouri:

- Dam Failures
- Drought
- Earthquakes
- Fires (Structural, Urban, and Wild)
- Heat Wave
- Land Subsidence/Sinkholes*
- Riverine Flooding (Includes Flash Floods and Levees)
- Severe Winter Weather (Snow, Ice, and Extreme Cold)
- Tornadoes and Severe Thunderstorms (Downbursts, Lightning, Hail, Heavy Rains, and Wind)

* Added in 2007

This list of hazards was revisited by the HMPT during the 2007 update of this plan. Based on a recommendation from the Division of Geology and Land Survey, the HMPT agreed that land subsidence/sinkholes does result in property losses in Missouri and should be looked at more closely. It has been added to the Profiling Hazards section in this plan, along with recently available mapping of this hazard. This is the only change to the hazards identified in the 2004 plan.

During the planning process, it was noted that levee failures may warrant profiling as a separate hazard in future updates to this plan. Levee issues are discussed presently in the riverine flooding profile. Currently, there is limited data on levees and their locations and conditions, but this should improve due to recently initiated nationwide levee certification efforts.

It was also noted that severe thunderstorms and associated subhazards could be profiled separately from tornadoes. The profile currently emphasizes tornadoes, as that hazard has resulted in severe property losses and loss of life and impacts state resources much more than severe thunderstorms (losses to hail and high wind are typically insured losses that are localized and do not result in presidential disaster declarations). Severe thunderstorms/heavy rains that lead to flooding are accounted for in the Riverine Flooding profile. SEMA will consider profiling severe thunderstorms separately during the 2008 update to its Hazard Analysis, recognizing that severe thunderstorms do cause problems at a local level.

The following natural hazards are not included in this analysis because they do not threaten Missouri: avalanches, coastal erosion, coastal storms, hurricanes, tsunamis, and volcanoes. While expansive soils, landslides, and rockfalls are recognized as hazards in Missouri, they occur infrequently and their impacts are minimal; so they will not be profiled further in this document.

Manmade and Other Hazards

Each year sees an increase in manmade incidents, which can be just as devastating as natural disasters. The following hazards could also affect Missouri:

- Attack (Chemical, Biological, Radiological, Nuclear, and Explosive)
- Civil Disorder
- Hazardous Materials
- Mass Transportation Accidents
- Nuclear Power Plants (Fixed Nuclear Facilities)
- Public Health Emergencies/Environmental Issues
- Special Events
- Terrorism
- Utilities (Interruptions and System Failures)

In the United States, 95 percent of all presidentially declared disasters have been related to weather or flood events. In Missouri, 100 percent of the presidentially declared disasters since 1975 have also been related to weather or flood events.

Presidential Declarations

Table 3.1 summarizes presidential declarations for Missouri since 1975.

Table 3.1. Presidential Declarations for Missouri Since 1975

Declaration Date	Disaster No.	Incident Type	No. of Counties Designated	Type of Assistance By County*
Major Disaster Declarations				
May 3, 1975	DR 466	Tornadoes, High Winds, Hail	4	IA & PA: 4
July 21, 1976	DR 516	Severe Storms, Flooding	4	IA & PA: 4
May 7, 1977	DR 535	Tornadoes, Flooding	7	IA & PA: 7
September 14, 1977	DR 538	Severe Storms, Flooding	6	IA & PA: 6
April 21, 1979	DR 579	Tornadoes, Torrential Rain, Flooding	17	IA Only: 1 IA & PA: 16
May 15, 1980	DR 620	Severe Storms, Tornadoes	1	IA Only: 1
August 26, 1982	DR 667	Severe Storms, Flooding	3	IA Only: 1 IA & PA: 2

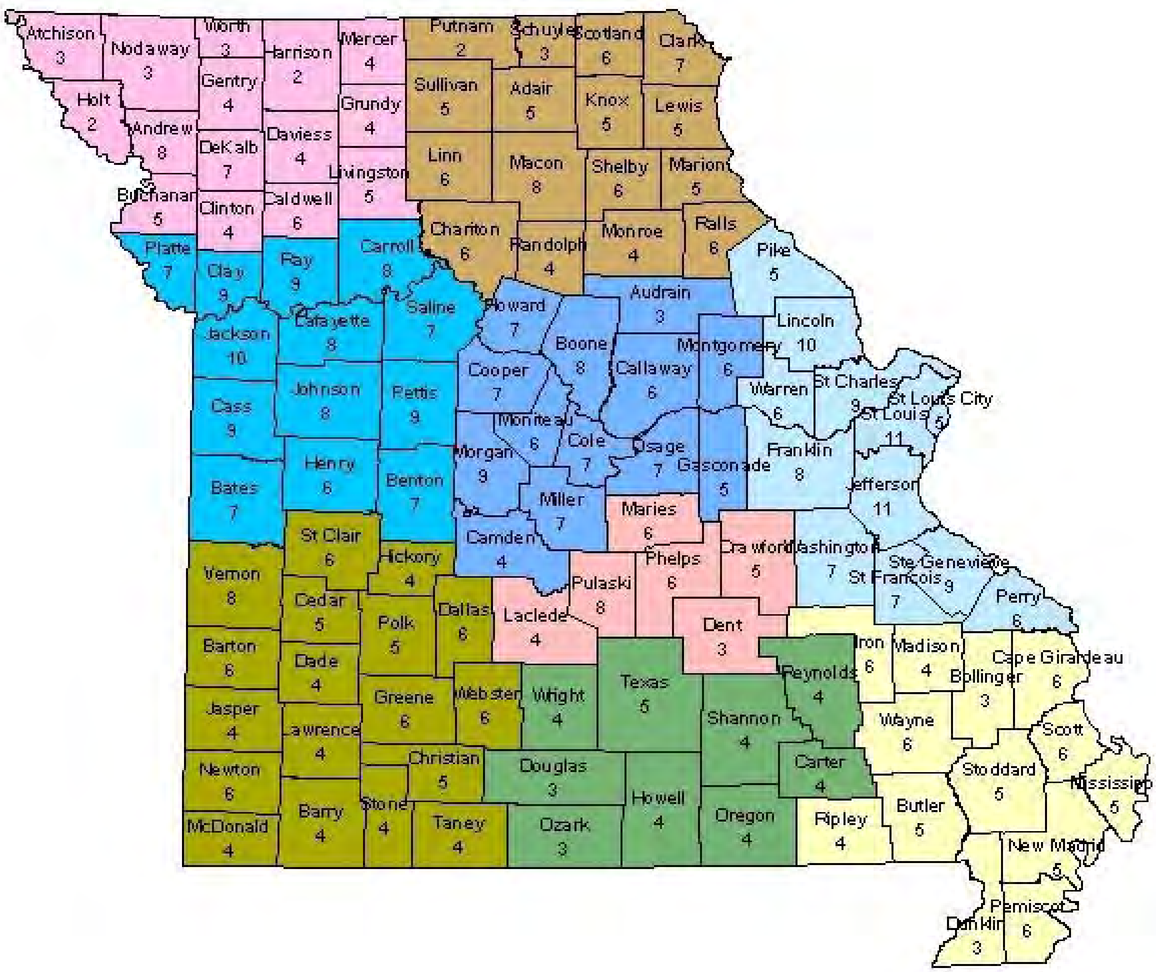
Declaration Date	Disaster No.	Incident Type	No. of Counties Designated	Type of Assistance By County*
December 10, 1982	DR 672	Severe Storms, Flooding	17	IA Only: 18 PA Only: 1 IA & PA: 5
June 21, 1984	DR 713	Severe Storms, Flooding	11	IA Only: 1 PA Only: 8 IA & PA: 2
October 14, 1986	DR 779	Severe Storms, Flooding	30	IA Only: 7 PA Only: 15 IA & PA: 8
May 24, 1990	DR 867	Flooding, Severe Storm	10	IA Only: 2 IA & PA: 8
May 11, 1993	DR 989	Severe Storm, Flooding	8	IA Only: 8
July 9, 1993	DR 995	Flooding, Severe Storm	101 & St. Louis City	IA Only: 14 IA & PA: 88
December 1, 1993	DR 1006	Flooding, Severe Storm, Tornadoes	24	IA Only: 10 IA and PA: 14
April 21, 1994	DR 1023	Severe Storm, Flooding, Tornadoes	17 & St. Louis City	IA Only: 18
June 2, 1995	DR 1054	Severe Storm, Tornadoes, Hail, Flooding	61 & St. Louis City	IA Only: 19 IA & PA: 43
October 14, 1998	DR 1253	Severe Storm and Flooding	19	IA and PA: 5 PA Only: 14
October 19, 1998**	DR 1256	Severe Storm and Flooding	2 & St. Louis City	IA Only: 3
April 20, 1999	DR 1270	Severe Storms and Flooding	6	IA Only: 6
May 12, 2000	DR 1328	Severe Thunderstorms and Flash Flooding	10	IA: 10 IA and PA: 3
February 6, 2002	DR 1403	Ice Storm	43	IA Only: 17 IA and PA: 26
May 6, 2002	DR 1412	Severe Storms and Tornadoes	79	IA Only: 9 PA Only: 31 IA and PA: 39
May 6, 2003	DR 1463	Severe Storms, Tornadoes, and Flooding	76	IA Only: 42 PA Only: 2 IA and PA: 32
June 11, 2004	DR 1524	Severe Storms, Tornadoes, and Flooding	37	IA: 37
March 16, 2006	DR 1631	Severe Storms, Tornadoes, and Flooding	41	IA Only: 12 PA Only: 4 IA and PA: 25
April 5, 2006	DR 1635	Severe Storms, Tornadoes, and Flooding	7	IA Only: 3 IA and PA: 4

Declaration Date	Disaster No.	Incident Type	No. of Counties Designated	Type of Assistance By County*
November 2, 2006 ***	DR 1667	Severe Storms	St. Louis City	PA Only: 1
December 29, 2006	DR 1673	Severe Winter Storms	13 & St. Louis City	PA Only: 14
January 15, 2007	DR 1676	Severe Winter Storms and Flooding	38 & St. Louis City	PA Only: 39
Emergency Declarations				
March 12, 1979	EM 3071	Ice Jam, Flooding	2	PA Only: 2
September 10, 2005	EM 3232	Hurricane Katrina Evacuation	114 & St. Louis City	PA Only: 115
July 21, 2006	EM 3267	Severe Storms	7 & St. Louis City	PA Only: 8
Fire Management Assistance				
March 9, 2000	FMA 2292	Camden Fire Complex	n/a	n/a

Source: Federal Emergency Management Agency
Notes:
*IA denotes Individual Assistance; PA denotes Public Assistance
**Declaration was for incident in July 1998 and approved October 19, 1998, following state appeal
***Declaration was for incident in July 2006 and approved November 2, 2006

Figure 3.5 illustrates the declared disasters in Missouri, 1993 to the present.

Figure 3.5. Declared Disasters,1993–Present



Source: Missouri State Emergency Management Agency
Note: Colored areas indicate regions represented by SEMA's Planning and Disaster Recovery Branch's area coordinators.

Table 3.2 shows the total amount of Public Assistance eligible for disaster declarations in Missouri from 1990 through early 2007. Public Assistance includes state and federal assistance for uninsured losses to public property and infrastructure within those counties included in the disaster declaration.

Table 3.2. Public Assistance for Missouri Disasters, 1990–2006

Declaration Date	Disaster No.*	Number of Applicants	Damage Survey Reports/Project Worksheets	Total Amount Eligible
May 24, 1990	DR 867	72	2,023	$9,461,555
July 9, 1993	DR 995	901	14,479**	$140,859,657**
December 1, 1993	DR 1006	38	565**	$3,281,066**
June 2, 1995	DR 1054	329	2,275**	$17,404,027**
October 14, 1998	DR 1253	104	869	$11,217,783**
May 12, 2000	DR 1328	31	183	$3,359,092
February 6, 2002	DR 1403	247	654	$64,117,838
May 6, 2002	DR 1412	338	1679	$47,657,062
May 6, 2003	DR 1463	160	552	$21,494,880
September 10, 2005	EM 3232	12	22	$1,810,674
March 16, 2006	DR 1631	129	249	$7,087,060
April 5, 2006	DR 1635	28	110	$8,611,859
July 21, 2006	EM 3267	132	70	$2,727,283
November 2, 2006***	DR 1667	n/a	n/a	n/a
December 29, 2006	DR 1673	n/a	n/a	n/a

Notes:
*DR denotes disaster declaration; EM denotes emergency declaration
**Figures as of June 1999
***Declaration was for incident in July 2006 and approved November 2, 2006

Table 3.3 shows the total amount of Individual Assistance (IA) for IA-declared disasters in Missouri from 1990 through 2006. Individual assistance includes state and federal assistance to individuals and families for uninsured losses within those counties included in the disaster declaration.

Table 3.3. Individual Assistance for Missouri Disasters, 1990–2006

Declaration Date	Disaster No.*	Individual Assistance	Number of Applicants
May 24, 1990	DR 867	$4,000,000	700
May 11, 1993	DR 989	$1,591,241	447
July 9, 1993	DR 995	$65,690,976	15,478
December 1,1993	DR 1006	$2,796,562	673
April 21, 1994	DR 1023	$2,116,639	779
June 2, 1995	DR 1054	$4,297,039	1,868
October 14, 1998	DR1253	$1,251,679	1,623**
October 19, 1998***	DR 1256	$1,093,865	1,763**
April 20, 1999	DR 1270	$559,725	203**
May 12, 2000	DR 1328	$2,897,686	515
February 6, 2002	DR 1403	$3,656,665	8,376
May 6, 2002	DR 1412	$8,774,608	6,834
May 6, 2003	DR 1463	n/a	n/a
June 11, 2004	DR 1524	$1,383,743	1,209
March 16, 2006	DR 1631	$1,533,97	2,312
April 5, 2006	DR 1635	$2,470,814	n/a

Notes:
*DR denotes disaster declaration; EM denotes emergency declaration
**Figures as of June 1999
***Declaration was for incident in July 1998 and approved October 19, 1998

Table 3.4 shows the United States' most expensive presidentially declared disasters.

Table 3.4. Most Expensive Presidentially Declared Disasters (Based on FEMA Funding)

Event	Year	FEMA Funding
Hurricane Katrina	2005	$29,318,576,948**
Attack on America	2001	$8,818,350,120
Northridge Earthquake	1994	$6,978,325,877
Hurricane Rita	2005	$3,749,698,351
Hurricane Ivan	2004	$2,431,034,355
Hurricane Georges	1998	$2,245,157,178
Hurricane Wilma	2005	$2,110,738,364
Hurricane Charley	2004	$1,885,466,628
Hurricane Andrew	1992	$1,813,594,813
Hurricane Frances	2004	$1,773,440,505

Source: Federal Emergency Management Agency
Notes:
*Numbers are in actual dollars, not adjusted for inflation
**Approximately 68 percent funded

3.2 Profiling Hazards

Requirement §201.4(c)(2)(i):	[The state risk assessment shall include an overview of the] location of all natural hazards that can affect the state, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate.

This Hazard Analysis assesses various risks facing the state and its communities in order to evaluate and rank them. This process is then used to characterize hazards for emergency planning. It estimates the probability of occurrence and the severity of consequences for each hazard and provides a method of comparison. The evaluation involves many interrelated variables (toxicity, demographics, topography, etc.), and should be used by state and local officials in planning and prioritizing allocation of resources.

A careful examination of hazard event profiles relevant to the Missouri study area serves to define historic hazard trends and provides a reference point for understanding the potential impacts from future predicted events. Reviewing historic data assists in evaluating hazard event profiles, which focus on answering the following questions: How often might a particular disaster occur? Where are we most likely to be affected? and, How bad can it get?

The hazards covered in the analysis are listed in Tables 3.5 and 3.6 along with the ratings they were given by the Hazard Mitigation Planning Team. The hazards are those that have been experienced by, or pose a potential threat to, Missourians. However, local or isolated problems that constitute potential disasters should not be overlooked. The ratings are situational dependent.

Table 3.5. Natural Hazards Profiled in Mitigation Plan

Natural Hazards	Probability	Severity
Dam Failure	Low	Moderate
Drought	Moderate	Moderate
Earthquakes	High	High
Fires: Structural & Urban Wild	 High Moderate	 Moderate Low to Moderate
Heat Wave	Moderate	Moderate
Land Subsidence/Sinkholes	High	Low
Riverine Flooding (Major and Flash)	High	High
Severe Winter Weather/Snow/Ice/Severe Cold: North of MO River South of MO River	 High Moderate	 Moderate Moderate
Tornadoes/Severe Thunderstorms	High	High

Table 3.6. Manmade and Other Hazards Profiled in Mitigation Plan

Manmade and Other Hazards	Probability	Severity
Attack (Nuclear, Conventional, Chemical, and Biological)	Low	High
Civil Disorder	Low	Low to High
Hazardous Materials Release: Fixed facility accidents Transportation accidents	 Moderate High	 Moderate Moderate
Mass Transportation Accidents	Moderate	Moderate
Nuclear Power Plants (Emergencies and Accidents)	Low	Moderate
Public Health Emergencies/Environmental Issues	High	Moderate to High
Special Events	Low	Low to High
Terrorism	Moderate	Low to High
Utilities (Interruptions and System Failures)	High	Low

The following definitions explain the ratings for each hazard:

Probability—The likelihood that the hazard will occur.

- **Low—**The hazard has little or no chance of happening (Less than 1 percent chance of occurrence in any given year.).
- **Moderate—**The hazard has a reasonable probability of occurring (Between 1 and 10 percent chance of occurrence in any given year).

- High—The probability is considered sufficiently high to assume that the event will occur (Between 10 and 100 percent chance of occurrence in any given year).

Severity—The deaths, injuries, or damage (property or environmental) that could result from the hazard.

- **Low—**Few or minor damage or injuries are likely.
- **Moderate—**Injuries to personnel and damage to property and the environment is expected.
- **High—**Deaths and major injuries and damage will likely occur

Based on the ratings, the hazards with both high probability and severity were prioritized for additional vulnerability analysis. While each of the hazards in the table will be profiled in this section, flooding, tornadoes, and earthquakes pose the most significant threat and were studied further using the risk assessment methodology. The state prioritized resources towards estimating losses from these significant hazards and in 2007 included a major effort to quantify flood losses statewide using HAZUS-MH, as well as improved tornado and earthquake risk assessments. See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction and Section 3.4 Assessing Vulnerability and Estimating Potential Losses of State Facilities for more information on vulnerability and estimated losses from these hazards. Public health emergencies/environmental issues also have high probability and potentially high severity, but estimated damage and loss are more difficult to quantify as they may occur as a primary or secondary hazard (i.e., as a result of a flood). Also, the location of impact is very broad in comparison to other more typical locations such as proximity to earthquake fault lines, tornado corridors, or floodplains.

An impact analysis of the potential for detrimental impacts of hazards was conducted for the Emergency Management Accreditation Program (EMAP). The results are presented in each profile’s discussion of impact.

Hazards are profiled below alphabetically. Natural hazards precede the manmade and other hazards.

3.2.1 Dam Failures

Description of Hazard

Over the years, dam failures have injured or killed thousands of people and caused billions of dollars of property damage in the United States. Among the most catastrophic were the failures of the Teton Dam in Idaho in 1976, which killed 14 people and caused more than $1 billion in damage, and the Kelly-Barnes Dam in Georgia, which left 39 dead and $30 million in property damage. In the past few years, over 200 documented dam failures occurred nationwide causing four deaths and millions in property damage and repair costs. The problem of unsafe dams in Missouri was underscored by dam failures at Lawrenceton in 1968, Washington County in 1975, Fredricktown in 1977, and the December 14, 2005, collapse of the upper reservoir of

AmerenUE’s Taum Sauk hydroelectric complex in Reynolds County. Overall, many of Missouri’s smaller dams are becoming a greater hazard as they continue to age and deteriorate. While hundreds of them need to be rehabilitated, lack of funding and questions of ownership loom as obstacles.

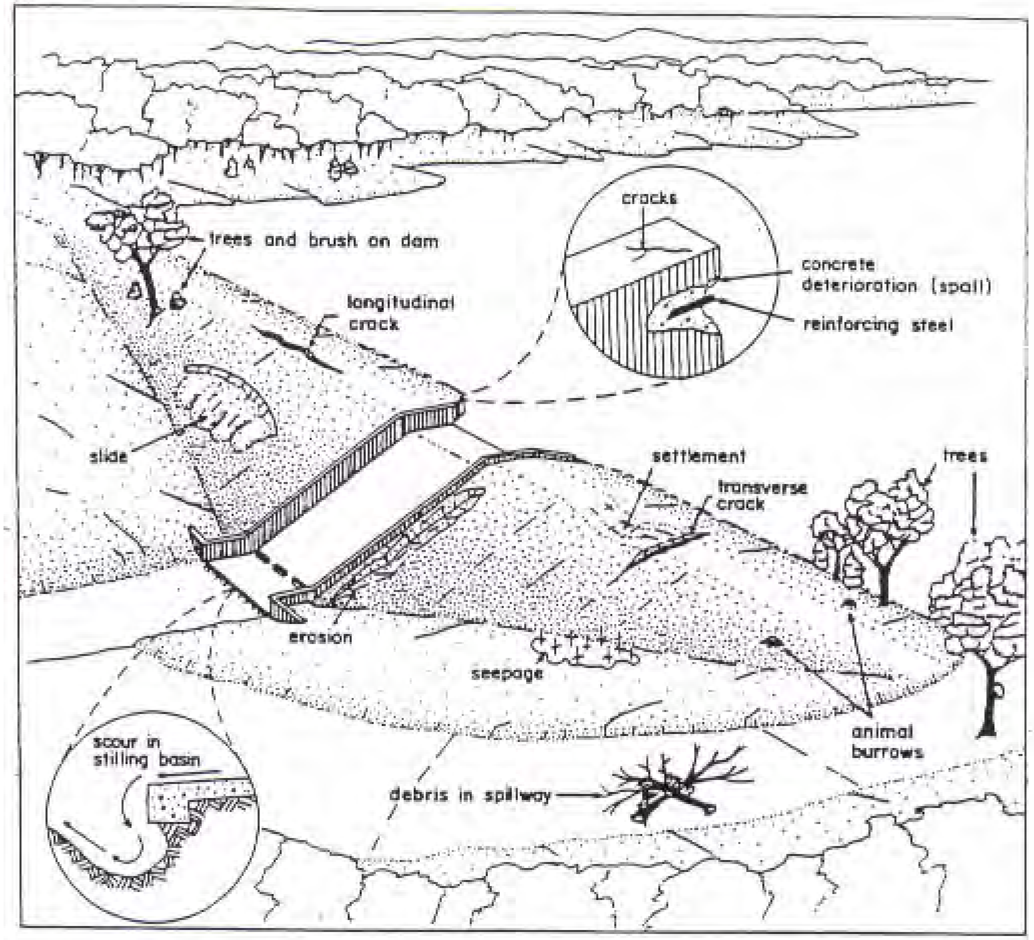
A dam is defined by the National Dam Safety Act as an artificial barrier that impounds or diverts water and (1) is more than 6 feet high and stores 50 acre feet or more or (2) is 25 feet or more high and stores more than 15 acre feet. Based on this definition, there are approximately 80,000 dams in the United States. Over 95 percent of these dams are nonfederal, with most being owned by state governments, municipalities, watershed districts, industries, lake associations, land developers, and private citizens. Dam owners have primary responsibility for the safe design, operation, and maintenance of their dams. They also have responsibility for providing early warning of problems at the dam, for developing an effective emergency action plan, and for coordinating that plan with local officials. The state has ultimate responsibility for public safety; many states regulate construction, modification, maintenance, and operation of dams and also implement a dam safety program.

Dams can fail for many reasons. The most common are as follows:

- **Piping—**Internal erosion caused by embankment leakage, foundation leakage, and/or deterioration of pertinent structures appended to the dam
- **Erosion—**Inadequate spillway capacity causing overtopping of the dam, flow erosion, and/or inadequate slope protection
- **Structural Failure—**Caused by an earthquake, slope instability, and/or faulty construction

These three types of failures are often interrelated. For example, erosion, either on the surface or internal, may weaken the dam, which could lead to structural failure. Similarly, a structural failure could shorten the seepage path and lead to a piping failure. Observable defects that provide good evidence of potential dam failures are illustrated in Figure 3.6.

Figure 3.6. Observable Defects



Dam construction varies widely throughout the state. Most dams are of earthen construction. Missouri's mining industry has produced numerous tailing dams for the surface disposal of mine waste. These dams are made from mining material deposited in slurry form in an impoundment. Other types of earthen dams are reinforced with a core of concrete or asphalt. The largest dams in the state are built of reinforced concrete and are used for hydroelectric power.

Historical Statistics

Missouri had some 4,100 recorded dams in July 2003, the largest number of manmade dams of any state in the United States. The topography of the state allows lakes to be built easily and inexpensively, which accounts for the high number. Despite such a large number, only about 620 Missouri dams (about 20 percent) fall under state regulations, while another 85 dams are federally controlled. A nonfederal dam can be anything from a large farm pond (e.g., MFA Research Farm Lake Dam in Saline County, which is 20 feet high and holds back 60 acre feet of water) to Bagnell Dam, which created the Lake of the Ozarks. Most nonfederal dams are privately owned structures built either for agricultural or recreational use. Missouri also has some 600 dams that were built as small watershed projects under Public Law 83-566 (Watershed

Protection and Flood Prevention Act of 1954). These dams serve many functions, including flood control, erosion control, recreation, fish and wildlife habitat, water supply, and water quality improvement. Many of these PL 83-566 dams need ongoing maintenance to safely provide these functions. Another group of older dams in the state were originally built by railroad companies as holding ponds for water to be used in steam locomotives. Many of these are now used as drinking water reservoirs by nearby towns and cities. Table 3.7 lists the primary purposes of dams in Missouri.

Table 3.7. Dams in Missouri by Primary Purpose

Purpose	Number	Percent
Fire and Farm Ponds	381	10.8
Flood Control	285	8.0
Hydroelectric	8	0.2
Irrigation	296	8.4
Navigation	7	0.2
Recreation	1,826	51.6
Tailings and Others	487	13.8
Water Supply	243	6.9
Undetermined	8	0.1

According to Stanford University's National Performance of Dams Program, there were 72 dam incidents in Missouri between 1975 and 2001 (see Table 3.8). Of these 72 incidents, 16 (22 percent) of them were failures.

Table 3.8. Dam Incidents in Missouri, 1975-2001

Dam Name	Incident Date	Incident Type	Dam Failure
Lake Flamingo Dam	6/6/2001	Seepage/Piping	No
Junior Lake Dam	11/14/2001	Swallow Hole	No
T-69 Watershed Site	8/22/2001	Concrete Deterioration	No
Lake Venita Dam	2/21/1997	Seepage; Piping	Yes
Carp Lake Dam	3/2/1997	Embankment Slide	No
Unnamed Dam	3/5/1997	Inflow Flood—Hydrologic Event	No
Unnamed Dam (Schacktenberg Company Dam?)	8/2/1997	Seepage; Piping	No
Schacktenberg Company Dam	2/26/1997	Animal Attack	No
Macon Lake Dam	5/7/1996	Inflow Flood—Hydrologic Event	No
Tamarack Dam	5/31/1996	Inflow Flood—Hydrologic Event	No
Block Lake Dam	4/28/1996	Inflow Flood—Hydrologic Event	No
Iron Mountain Lake Dam	4/22/1996	Embankment Erosion	No
102 Riv Trib Wtrshd Strctr Lt-36	12/4/1996	Debris—Reservoir	No
Bowling Green #1 Dam	6/26/1995	Seepage; Piping	No
Nehai Tonkayea Lake Dam	12/10/1995	Embankment Slide	No
City Of Higbee Dam	3/23/1995	Embankment Slide	No

Dam Name	Incident Date	Incident Type	Dam Failure
Wells Lake Dam	12/7/1995	Cracks/Tree Growth	No
Unnamed Dam	8/24/1995	Inflow Flood—Hydrologic Event	No
Owl Creek Estates Dam No. 3	8/31/1995	Embankment Slide	No
Lake Arrowhead Dam	5/17/1995	Inflow Flood—Hydrologic Event	No
Sunny Shores Dam	6/21/1995	Seepage	No
Prairie Lee Lake Dam	4/22/1994	Embankment Slide	No
Lake Arrowhead Dam	11/15/1994	Embankment Slide	No
Seven Lakes #1	8/24/1994	Embankment Slide	No
Dresser #11 Tailings Pond Dam	2/17/1994	Concrete Deterioration	No
Silver Creek Lake Dam	6/21/1994	Concrete Deterioration	No
Unnamed Dam	8/30/1994	Seepage; Piping	No
Unnamed Dam	7/14/1994	Debris—Reservoir	No
Bettison	5/26/1994	Embankment Slide	No
Goose Creek Dam	4/27/1994	Concrete Deterioration	No
Four Winds Way Dam	3/1/	Concrete Deterioration	No
Shatto Lake Mill Dam	7/21/1994	Inflow Flood—Hydrologic Event	No
Mozingo Creek Dam	7/7/1994	Inflow Flood—Hydrologic Event	No
Holiday Acres Lake Dam	1/3/1994	Seepage; Embankment Slide	No
Stevens Lake Dam	6/1993	Inflow Flood—Hydrologic Event	Yes
Lake Marie Dam	7/8/1993	Embankment Erosion	No
Norman Swinney's Dam	5/26/1993	Inadequate Compaction	Yes
Freddies Lake Dam	9/26/1993	Inflow Flood—Hydrologic Event	Yes
Boyd Lake Dam	9/25/1993	Embankment Slide	Yes
Sunny Mount Dam	9/23/1993	Animal Attack	No
Las Brisas Lake Dam	5/24/1993	Seepage; Embankment Erosion	No
Harrison County Lake	1/3/1993	Inflow Flood—Hydrologic Event	Yes
F.E.M., Inc. Lake Dam	8/11/1993	Inflow Flood—Hydrologic Event	No
Robbins Lake Dam	5/26/1993	Embankment Slide	No
Lake Viking Dam	8/9/1993	Inflow Flood—Hydrologic Event	No
Trenton Lower Lake Dam	7/14/1993	Inflow Flood—Hydrologic Event	No
Lac Shayne Dam	10/7/1993	Embankment Slide	No
Bockelman Lake Dam	7/1993	Inflow Flood—Hydrologic Event	Yes
Hidden Lake Dam	7/16/1993	Embankment Erosion	No
Carp And Commandeer Dams	7/14/1993	Inflow Flood—Hydrologic Event	No
Fellows Lake Dam	10/28/1993	Concrete Deterioration	No
Miller Lake Dam	4/2/1992	Embankment Slide	No
No Name (owned by Lonnie Hollaway)	5/25/1992	Embankment Slide	No
Unnamed Dam (MOS00015)	6/5/1992	Erosion	Yes
ISP Minerals, Inc. Plant	6/3/1992	Not Known	Yes
Hester Lake Dam	4/9/1991	Piping	Yes
Mcnulty Lake Dam	5/13/1991	Inflow Flood—Hydrologic Event	No
Brushy Creek Tailings Dam	1/9/1991	Toe Berm Erosion	No
Brays Lake Dam	5/13/1991	Inflow Flood—Hydrologic Event	No
Bullard Lake Dam	5/15/1990	Inflow Flood—Hydrologic Event	No
Allen Dale Subdivision Dam	5/21/1990	Inflow Flood—Hydrologic Event	No
St. Joe State Park Sediment	2/15/1990	Inflow Flood—Hydrologic Event;	Yes

Dam Name	Incident Date	Incident Type	Dam Failure
Impoundment		Inadequate Spillway Capacity	
Rogue Creek Upper Dam (Imcompleted)	5/25/1990	Inflow Flood—Hydrologic Event	No
Pinnacle Lake Dam	6/7/1990	Inflow Flood—Hydrologic Event	No
Woodridge Lake Dam	6/8/1990	Embankment Erosion	No
Christiansen Lake Dam	5/1990	Embankment Erosion	Yes
Bass Lake Dam	5/15/1990	Inflow Flood—Hydrologic Event	No
Marschke Lake Dam	4/19/1988	Not Known	Yes
Richardet Dam	12/1985	Seepage; Embankment Slide	Yes
Pinkston	1978	Piping	Yes
Unnamed Dam (MOS00014)	1977	Inflow Flood—Hydrologic Event	No
Dresser No.4 Dam (Failed)	8/15/1975	Piping	Yes

Source: Stanford University, National Performance of Dams Program, http://npdp.stanford.edu/

On December 14, 2005, the Taum Sauk reservoir dam owned by AmerenUE of St. Louis failed. A 600-foot breech in the northwest side of the retention facility released 1.5 billion gallons of stored water into the Johnson Shut-Ins State Park in 10 minutes. The waters destroyed the park and the park superintendent's house and swept the superintendent's family out of their house. All five family members survived. The lower reservoir was overtopped by the flow of the east fork of the Black River. As a precautionary measure, the City of Lesterville (Reynolds County) evacuated 100-150 people to higher ground. If the dam had failed during the summer months, during the park's peak use, it is likely that many lives would have been lost.

Missouri's Department of Natural Resources (DNR) Water Resources Center maintains a Dam and Reservoir Safety Program. The objective is to ensure that dams are safely constructed, operated, and maintained pursuant to Chapter 236 Revised Statutes of Missouri. Under that law, a dam must be 35 feet or higher to be state regulated. These dams are surveyed by state inspectors at least every five years. However, most Missouri dams are less than 35 feet high and thus are not regulated. While the state has for many years encouraged dam owners to inspect those unregulated dams, the condition of some of these small structures may be inadequate.

Measure of Probability and Severity

Probability: Low
Severity: Moderate

Dams are generally classified in three categories that identify the potential hazard to life and property should a failure occur:

- **High Hazard**—If the dam was to fail, lives would be lost and extensive property damage could result.
- **Significant Hazard**—Failure could result in the loss of life and appreciable property damage.

- **Low Hazard—**Failure results in only minimal property damage.

Table 3.9 breaks down the number of dams by county and indicates the hazard potential classification of those dams in that county. Figure 3.7 illustrates the number of dams by county.

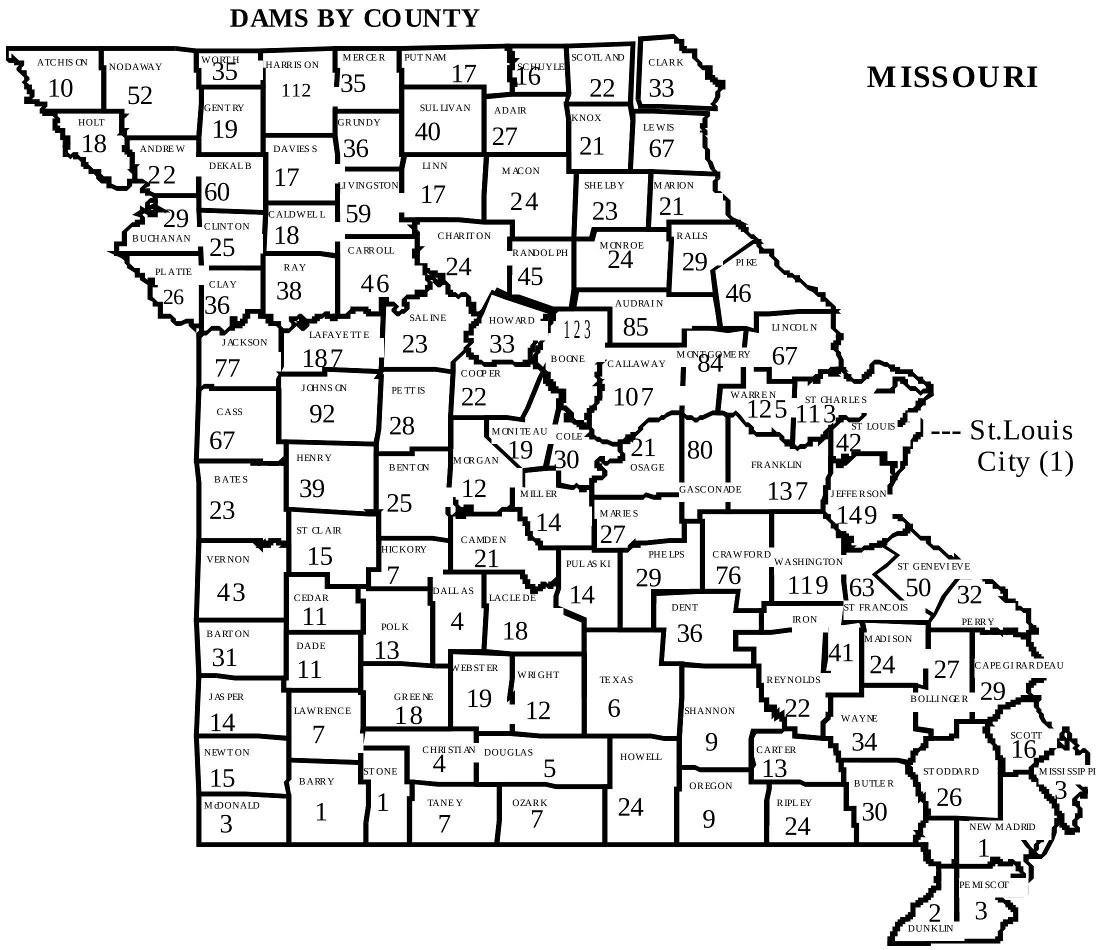
Table 3.9. Dams in Missouri by County and the Threat of Dam Failure in Each County

County	Number of Dams	Hazard Potential Classification		
		High	Significant	Low
Adair	27	2	6	19
Andrew	22	4	7	11
Atchison	10	1	1	8
Audrain	85	5	23	57
Barry	1	0	0	1
Barton	31	0	4	27
Bates	23	2	7	14
Benton	25	3	5	17
Bollinger	27	4	8	15
Boone	123	28	26	69
Buchanan	29	5	8	16
Butler	30	1	8	21
Caldwell	18	1	4	13
Callaway	107	9	24	74
Camden	21	5	6	10
Cape Girardeau	29	12	4	13
Carroll	46	1	8	37
Carter	13	1	4	8
Cass	67	13	18	35
Cedar	11	1	1	9
Chariton	24	1	2	21
Christian	4	0	1	3
Clark	33	2	3	28
Clay	36	9	10	17
Clinton	25	1	7	17
Cole	30	5	15	10
Cooper	22	0	2	20
Crawford	76	8	21	47
Dade	11	0	1	10
Dallas	4	0	1	3
DeKalb	60	2	17	41
Dent	36	6	10	20
Douglas	5	0	2	3
Dunklin	2	1	1	0
Franklin	137	22	32	83
Gasconade	80	8	14	58
Gentry	19	1	4	14

County	Number of Dams	Hazard Potential Classification		
		High	Significant	Low
Greene	18	10	3	5
Grundy	36	4	6	26
Harrison	112	2	44	64
Henry	39	0	6	33
Hickory	7	1	1	5
Holt	18	3	4	11
Howard	33	5	2	25
Howell	24	2	7	15
Iron	41	14	8	19
Jackson	77	27	18	32
Jasper	14	2	3	9
Jefferson	149	60	48	41
Johnson	92	10	14	68
Knox	21	0	6	15
Laclede	18	0	7	11
Lafayette	187	2	41	144
Lawrence	7	0	0	7
Lewis	67	0	16	51
Lincoln	67	7	23	37
Linn	17	2	6	9
Livingston	59	1	16	42
McDonald	3	1	0	2
Macon	24	3	3	18
Madison	24	12	8	4
Maries	29	0	7	22
Marion	21	1	4	16
Miller	14	4	4	6
Mississippi	3	0	0	3
Moniteau	19	2	4	13
Monroe	24	2	5	17
Montgomery	84	10	18	55
Morgan	12	0	2	10
New Madrid	1	0	0	1
Newton	15	6	4	5
Nodaway	52	1	12	39
Oregon	9	2	1	6
Osage	21	3	10	8
Ozark	7	1	4	2
Pemiscot	3	0	0	3
Perry	32	12	7	13
Pettis	28	3	4	21
Phelps	29	4	8	17
Pike	46	2	16	28

County	Number of Dams	Hazard Potential Classification		
		High	Significant	Low
Platte	26	7	8	10
Polk	13	0	2	11
Pulaski	14	0	0	14
Putnam	17	0	5	12
Ralls	29	5	8	16
Randolph	45	3	9	32
Ray	38	10	9	19
Reynolds	22	12	2	8
Ripley	24	0	8	16
St. Charles	113	19	28	65
St. Clair	15	0	1	14
St. Francois	63	20	23	20
Ste. Genevieve	50	18	16	16
St. Louis	42	22	14	6
St. Louis City	1	0	1	0
Saline	23	2	4	17
Scotland	22	3	2	17
Scott	16	3	2	11
Shannon	9	1	3	5
Shelby	23	2	5	16
Stoddard	26	8	5	13
Stone	1	1	0	0
Sullivan	40	1	7	32
Taney	7	3	1	3
Texas	6	0	2	4
Vernon	43	1	5	37
Warren	125	28	46	51
Washington	119	51	34	34
Wayne	34	15	9	10
Webster	19	1	9	9
Worth	35	1	3	31
Wright	12	0	6	6

Figure 3.7. Number of Dams by County



Source: Inventory of Dams, Missouri Department of Natural Resources, Dam and Reservoir Safety

The state has three classes that determine how often a state-regulated dam is inspected. They are:

- **Class 1**—Inspection occurs once every two years if 10 or more structures are downstream of the dam.
- **Class 2**—Inspection occurs once every three years if more than 1 or less than 10 structures are downstream of the dam.
- **Class 3**—Inspection occurs once every five years if no structures are downstream of the dam.

The state uses this system to ensure that the high and significant hazard dams are regularly inspected. An emergency action plan is required for all dams; however, it is not required to provide a copy to the state. Dam failure inundation mapping is not required in Missouri. Inundation maps that exist for U.S. Army Corps of Engineers regulated dams are not provided in this document due to homeland security concerns. In Missouri, about 5-10 percent of the dam structures are not in compliance with dam safety regulations. The Department of Natural

Resources coordinates with SEMA when a problem develops with a dam. If a problem occurs after hours or on a weekend, SEMA's duty officer is notified. The SEMA duty officer responds as appropriate to the situation's needs, according to a manual of procedures.

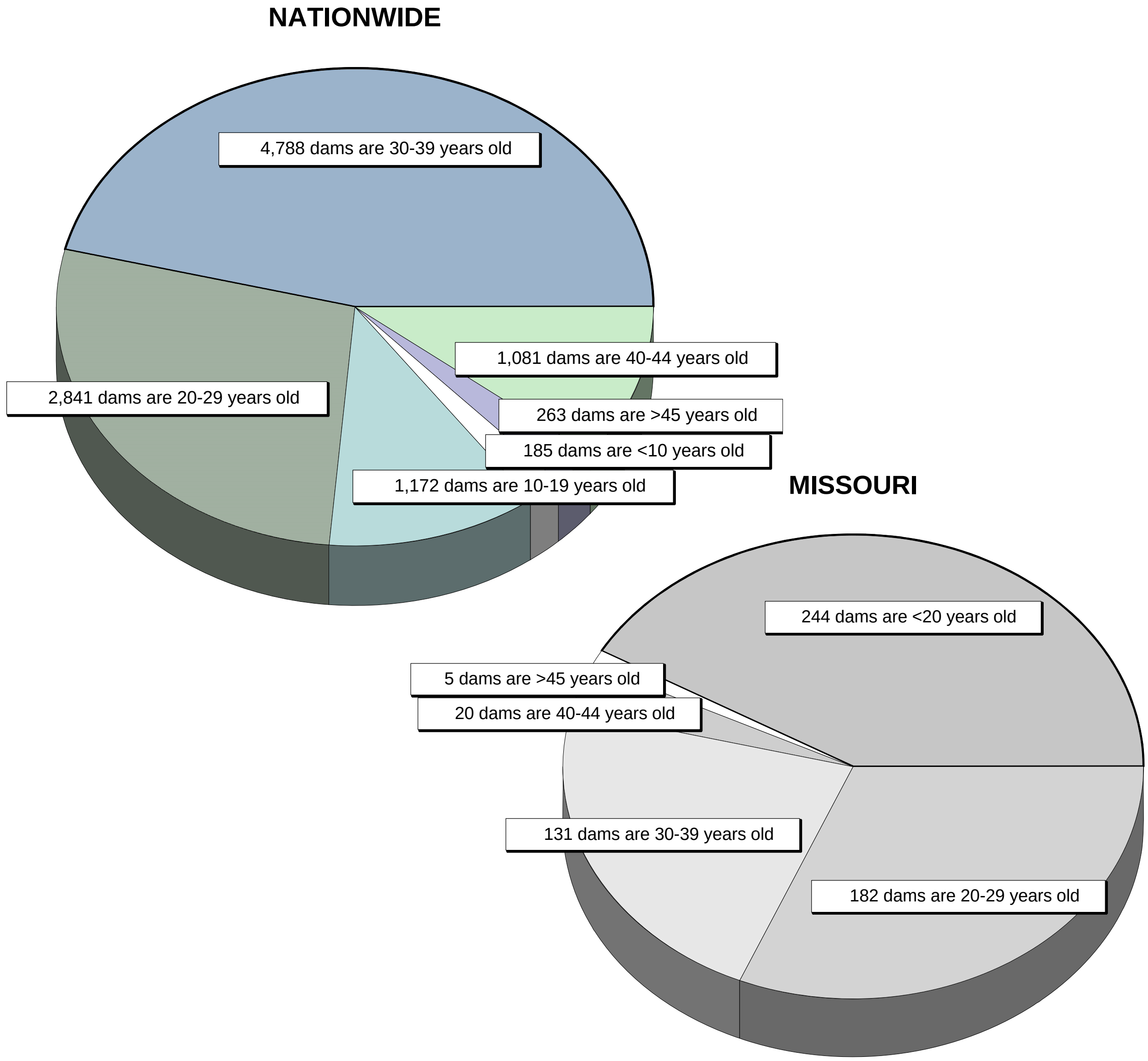
Status of Missouri Privately Owned Dams

According to the DNR 2003 Missouri Dam Database, 622 dams, or 15 percent of the dams surveyed, had a high hazard potential, while 992 dams, or 25 percent of the dams surveyed, had a significant hazard potential. Another 2,402 dams, or 60 percent of the dams surveyed, had a low hazard potential. However, many of Missouri's unregulated private dams have gone unchecked for decades, according to Jim Alexander, chief engineer for the DNR's dam safety program. Dams that don't get regular attention can erode over the years, or be damaged by floods, he notes. "There are accidents out there waiting to happen." Some of the potential hazardous dams are five miles from a downstream city. If a dam fails, the owner is still responsible for damage, Alexander says, "but there's no legal handle on them to maintain the dams" and ownership of unregulated dams is not always clear. Concern is mounting even for some of the state's regulated dams; particularly the Silver Creek Dam east of Rockaway Beach in Taney County, where the ownership is unknown. Erosion is eating away at the 40-foot-high dam, and the runoff creates silt deposits along the shore of Lake Taneycomo. One end of the dam is a barren clay bank that could give way during a heavy rainstorm, Alexander says. The DNR's plans were to obtain money through the state legislature to repair the dam and have the Attorney General's Office seek reimbursement from the owner when that person is identified.

Missouri's Small Watershed Projects with Dams

In 1954, Missouri built its first small watershed dam and today has over 600 built under PL 83-566. These dams vary in size and perform multiple functions, including flood and erosion control. Many have a designed life of 50 years. According to a 1999 report, about 25 of these dams are more than 40 years old, and most will need major rehabilitation soon. More than 130 dams are 30 to 39 years old, while 182 of them are 20 to 29 years old (see Figure 3.8).

Figure 3.8. Our Aging Dams—Survey of Small Watershed Dams



The Iowa Watershed Task Force published a series of case studies in 1999 on aging watershed dams. The Missouri case study on the Tabo Creek Watershed Project in Lafayette County best illustrates the range of problems. The Tabo Creek project was authorized in 1960, with the first dam constructed in 1961. Since then, 64 grade-stabilization dams have been installed. Many of these dams now face the same problems that plague older dams in other watersheds approaching the end of their 50-year design life. They include deteriorating pipes and sediment filling the reservoirs. The most common problem is decaying pipes, since 44 of the dams were installed with corrugated metal pipes. One of the most visible problems is the lakes filling with sediment. The Lafayette County Soil and Water Conversation District is responsible for operation and maintenance and performs annual inspections of each structure. However, the local sponsors don’t have the funds needed to rehabilitate all the structures, which would cost an estimated $6

million, the case study notes. To date, no dams built under the Small Watershed Program anywhere in the United States have failed and resulted in loss of life. However, some exhibited significant problems that were corrected before a catastrophic failure or tragedy has occurred. The chances of such occurrences will undoubtedly increase as the dams get older.

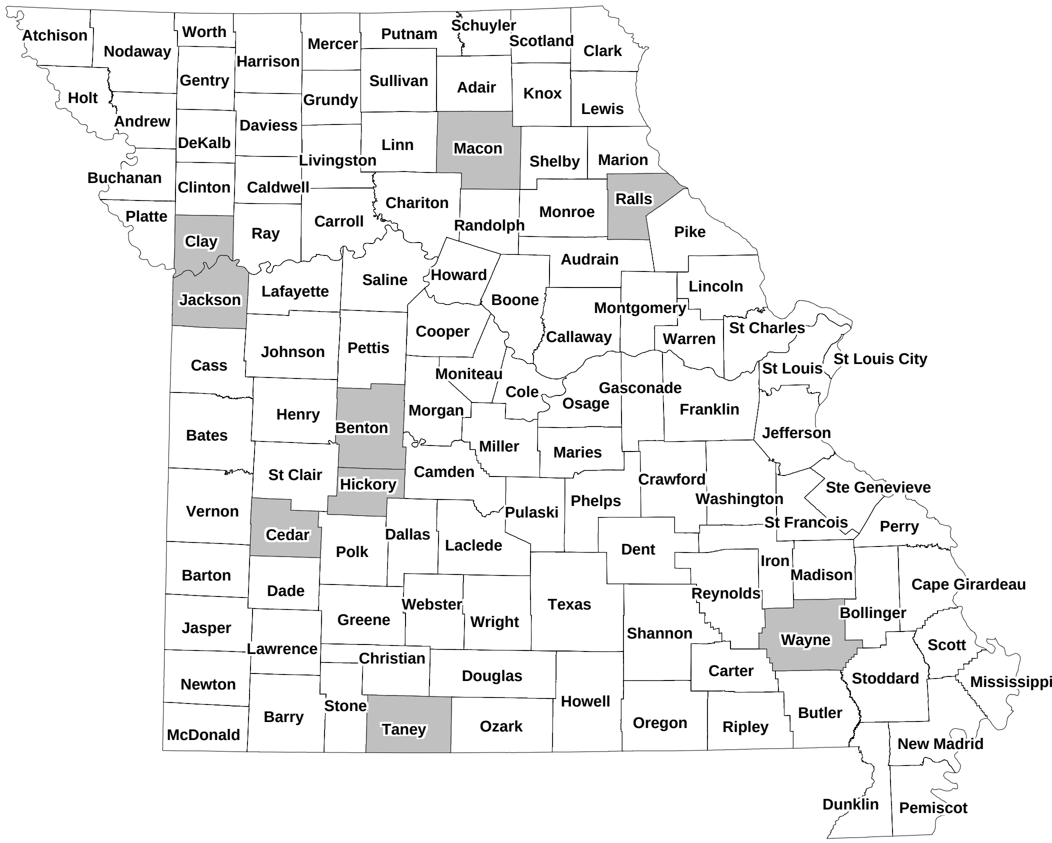
U.S. Army Corps of Engineers Operated Reservoir Dams in Missouri

The U.S. Army Corps of Engineers (Corps) operates and maintains nearly a dozen large federally regulated reservoir dams in Missouri through its Kansas City, St. Louis, and Little Rock Districts. Extensive care is taken by the Corps in the design, construction, and operation of their dams. As a result, the Corps' record for dam safety is considered excellent. Nevertheless, dam failures elsewhere in the country raise the possibility that any one of these facilities could fail. The threat of an earthquake in some areas of the state, the possibility of sabotage or terrorist activities, or other natural or technological events are among the potential risk factors that could cause such a structure to fail.

For its regulated dams, the Corps' Kansas City District began a program in 1999 to revise its contingency plans for seven district dams it operates in Missouri. The plans were republished as emergency action plans to provide an updated emergency notification/points of contact list in the event of a dam failure, to provide for increased communications with local emergency management officials, and to provide a more simplified format for clarity. The Corps' Kansas City District worked jointly with SEMA, the National Weather Service, and local officials, including the county sheriff and emergency management coordinator in the affected counties (24 hours below stream). The plans were updated for Pomme de Terre Dam (Hickory and Benton counties), Blue Springs Dam (Jackson County), Longview Dam (Jackson County), Smithville Dam (Clay and Platte counties), Long Branch Dam (Macon and Randolph counties), Stockton Dam (Cedar and St. Clair counties), and Truman Dam (Benton and Morgan counties). Two other counties, Schuyler and Putnam, were included in an updated plan for the Corps' Rathbun Dam in Iowa.

The Corps' St. Louis District maintains flood emergency plans for its Clarence Cannon Dam/Mark Twain Lake project, with the plan covering Ralls, Monroe, Pike, and Shelby counties and Lake Wappapello Dam for Wayne, Butler, Stoddard, and Dunklin counties. The Corps' Little Rock District has similar plans for Table Rock Dam (Taney and Ozark counties) and for Clearwater Dam (Wayne, Butler, and Reynolds counties). Figure 3.9 shows the location of the Corps' Missouri reservoir dams by county and adjacent counties that could be impacted (emergency notification) by a dam failure.

Figure 3.9. Missouri Counties with Corps of Engineers Reservoir Dams



In the event of a dam failure, emergency warning/notification procedures are provided in both Corps of Engineers flood emergency plans and local county emergency operations plans to alert local officials in the threatened areas. Emergency notification includes the county in which the dam is located and adjacent/nearby counties below stream that may also be impacted. The Corps maintains such emergency plans for each individual dam, and copies are kept on file with SEMA.

Missouri is particularly concerned about the high hazard Clearwater Dam in Wayne County, which is currently part of a Corps' major rehabilitation project. According to the Corps, Clearwater Dam has experienced seepage-related issues extending back to shortly after its completion in 1942. Various methods have been used over the years to remediate or reduce this problem. Nevertheless, the problems have worsened and in January 2003, a sinkhole in the upstream face of the dam further called into question the integrity of the dam. The area most at risk should the dam fail extends from the dam downstream to Poplar Bluff. It is estimated that such an event could cause 369 deaths and $200 million in property damage.

Dams located outside of the state's boundaries could impact Missouri as well. Of particular concern is the Tuttle Creek Dam in Riley, Pottawatomie, and Marshall Counties in northeast Kansas on the Big Blue River, nine miles upstream from the confluence of the Blue and Kansas rivers. It is situated near the Humboldt fault line, which is associated with the Nemaha Uplift. Earthquake models show that the dam could be significantly damaged to the point that the lake could wash out the dam. Efforts are under way to shore up the dam to withstand a moderate to

large earthquake. In the meantime, should this dam fail, floodwaters may travel east and impact Missouri.

Missouri's percentage of high hazard dams in the DNR inventory puts the state at about the national average for that category. However, the probability of dam failure increases as many of the smaller and privately owned dams continue to deteriorate without the benefit of further regulation or improvements. Based on this information, the state rates the overall probability of dam failure as low and the severity as moderate.

Impact of the Hazard

When a dam fails, the stored water can be suddenly released and have catastrophic effects on life and property downstream. Homes, bridges, and roads can be demolished in minutes. The failure of the Buffalo Creek Dam in 1972 in West Virginia killed 125 people. The 2005 collapse of the Taum Sauk upper reservoir destroyed the house of the superintendent of DNR's Johnsons Shut-ins State Park in Reynolds County. The family of five was rescued by the Lesterville Volunteer Fire Department. DNR is depending on AmerenUE to provide the funds to restore the park to its original condition. At least 26 recorded dam failures have occurred in 20 Missouri counties since the turn of the 20th century. Fortunately, only one drowning has been associated with a dam failure in the state, and there has been little consequence to property.

Residents near a high- or moderate-hazard dam should become familiar with the dam's emergency action plans. Emergency plans written for dams include procedures for notification and coordination with local law enforcement and other governmental agencies, information on the potential inundation area, plans for warning and evacuation, and procedures for making emergency repairs.

The information in Table 3.10 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.10. EMAP Impact Analysis: Dam Failure

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be severe for inundation area and moderate to light for other adversely affected areas.
Health and Safety of Personnel Responding to the Incident	Localized impact expected to limit damage to personnel in the inundation area at the time of the incident.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the inundation area of the incident. Some severe damage possible.
Delivery of Services	Localized disruption of roads and/or utilities may postpone delivery of some services.
The Environment	Localized impact expected to be severe for inundation area and moderate to light for other adversely affected areas.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time, depending on damage and length of investigation.
Regulatory and Contractual Obligations	Regulatory waivers may be needed locally. Fulfillment of some contracts may be difficult. Impact may reduce deliveries.
Reputation of or Confidence in the Entity	Localized impact expected to primarily adversely affect dam owner and local entities.

Synopsis

Dam breaks are caused most often by failure of the structure itself. However, flooding is the most common hazard associated with dam failure. Prolonged rains and flooding can saturate earthen dams, for example, producing much the same breaching effect as occurs with earthen levees. Flooding can also result in overtopping of dams when the spillway and reservoir storage capacities are exceeded. A large slide may develop in either the upstream or downstream slope of the embankment and threaten to release the impounded water. Complete structural collapse can occur, especially as a result of an earthquake.

Actual dam failure can result not only in loss of life, but also considerable loss of capital investment, loss of income, and property damage. Loss of the reservoir itself can cause hardship for those dependent on it for their livelihood or water supply.

3.2.2 Drought

Description of Hazard

Drought is not a hazard that affects just farmers, but can impact the nation's entire economy. Its outcome can adversely affect a small town's water supply, homeowners, the corner grocery store, commodity markets, and tourism. According to the National Drought Mitigation Center, drought costs the U.S. economy about $7 to 9 billion dollars a year. Losses from the 1988-1989 droughts were projected by Chamgnon and Riebsame and the White House Study Group at $39.2 billion for 1988, including about $51.6 billion in agricultural losses. The University of Missouri estimated the drought losses of 2002 and 2003 farm production years. Economic impact to the Missouri economy due to agricultural losses was $461 million for 2002 and $575 million in 2003.

The National Weather Service defines drought as "a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, and/or people." The Missouri Drought Response Plan distinguishes between five categories of drought, as follows:

- **Agricultural Drought—**Defined by soil moisture deficiencies
- **Hydrological Drought—**Defined by declining surface and groundwater supplies
- **Meteorological Drought—**Defined by precipitation deficiencies
- **Hydrological Drought and Land Use—**Defined as a meteorological drought in one area that has hydrological impacts in another area
- **Socioeconomic Drought—**Defined as drought that impacts supply and demand of some economic commodity

Each of these definitions relates the occurrence of drought to water shortfall in some component of the hydrological cycle. Each affects patterns of water and land use, and each refers to a repetitive climatic condition. In urban areas, drought can affect those communities that depend on reservoirs for water, and decreased water levels due to insufficient rain can lead to restricted water use. In agricultural areas, drought during the planting and growing season can have a significant impact on yield.

The U.S. government's definition of an agricultural drought incorporates specific parameters based on historical records. Agricultural drought is "a combination of temperature and precipitation over a period of several months leading to a substantial reduction in yield (bushels per acre) of one or more of the three major food grains (wheat, soybean, corn). A substantial reduction is defined as a yield (bushels per acre) less than 90 percent of the yield expected with temperature/precipitation equal to long term average values."

Regardless of the specific definition, droughts are difficult to predict or forecast, both as to when they will occur and how long they will last. According to Dr. Grant Darkow, Department of

Atmospheric Science, University of Missouri–Columbia, there is a recognizable "upper air-flow pattern and simultaneous surface pattern associated with abnormal dryness over Missouri." When the upper air-flow pattern is typified by air flowing in a broad arc over the central plains with higher speeds in southern Canada than over the United States, then the air over the southern plains will be "characterized by a weak clockwise circulation." Storm systems coming off the Pacific Ocean will cross the extreme northwestern states and southern Canada, thus bypassing the Midwestern states. When this flow pattern persists, the result can be a prolonged period of drought.

The most commonly used indicator of drought and drought severity is the Palmer Drought Severity Index (PDSI), which is published jointly by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Agriculture (USDA) (see Table 3.11). The PDSI measures the difference between water supply (in terms of precipitation and stored soil moisture) and demand (the amount of water required to recharge soil and keep rivers, lakes, and reservoirs at normal levels). The result is a scale from +4 to -4, at 1.0 and 0.5 intervals. By relating the PDSI to a regional index, one can compile data that reflects long-term wet or dry tendencies.

Table 3.11. Palmer Drought Severity Index

PDSI Number	Long-Term Tendency
Above 4.0	Extreme moist spell
3.0 to 3.9	Very moist spell
2.0 to 2.9	Unusually moist spell
1.0 to 1.9	Moist spell
0.5 to 0.9	Incipient moist spell
0.4 to -0.4	Near normal conditions
-0.5 to -0.9	Incipient drought
-1.0 to -.9	Mild drought
-2.0 to -2.9	Moderate drought
-3.0 to -3.9	Severe drought
Below -4.0	Extreme drought

For PDSI reporting purposes, Missouri is divided into six regions of similar climatic conditions: Northwest, Northeast, West Central, Southwest, Southeast, and Bootheel. These regions are illustrated in Figure 3.10.

Figure 3.10. Palmer Drought Severity Index: Missouri Subregions

In addition to the NOAA/USDA indices, water management agencies in Missouri have access to the Missouri Crop and Weather Report, produced by the Missouri Agricultural Statistics Service. These reports provide detailed statistical information on weather conditions, crop conditions, topsoil moisture supply, and subsoil moisture supply by subregion throughout Missouri.

Other less quantitative indicators of drought include high water demand versus available supplies, reduced stream flows, declining reservoir levels, precipitation deficits, falling water levels in wells, and low soil moisture.

The difficulty with recognizing or predicting drought is that no single indicator can be reliably used to predict onset. Regional indicators such as the PDSI are limited in that they respond slowly to deteriorating conditions, whereas observations of surface conditions and groundwater measurements or rainfall may only provide a "snapshot" of a very small area.

Consequently, the use of a variety of drought indicators is essential for effective assessment of drought conditions, and the PDSI is the primary means to assess drought severity.

Missouri’s Drought Response System is divided into four phases:

- **Phase I: Advisory Phase**—Requires a drought monitoring and assessment system to provide enough lead time for state and local planners to take appropriate action
- **Phase II: Drought Alert**—When the PDSI reads -1.0 to -2.0, and stream flows, reservoir levels, and groundwater levels are below normal over a several month period, or when the Drought Assessment Committee (DAC) determines that Phase II conditions exist based on other drought determination methods
- **Phase III: Conservation Phase**—When the PDSI reads -2.0 to -4.0, and stream flows, reservoir levels, and groundwater levels continue to decline, along with forecasts indicating an extended period of below-normal precipitation, or when the DAC determines that Phase III conditions exist based on other drought determination models
- **Phase IV: Drought Emergency**—When the PDSI is lower than -4.0, or when the DAC determines that Phase IV conditions exist based on other drought determination methods

Historical Statistics

According to the 2002 Missouri Drought Plan, Missouri’s average annual rainfall ranges from about 34 inches in the northwest to about 51 inches in southeast Missouri. Even the driest areas of Missouri have more rainfall than most western states; however, lack of rainfall impacts certain parts of the state more than others because of alternate source availability and usage patterns.

Southern Missouri—Most of the southern portions of Missouri are less susceptible to problems caused by prolonged periods without rain because of abundant groundwater resources in the region. Even with decreased stream flows or lowered reservoir levels, groundwater is still a viable resource in southern Missouri. Row-crop farming is not extensive; therefore agricultural needs aren’t as great as in other parts of the state. The only exception is in the southwestern and southeastern areas where irrigation is used.

Northern and West Central Missouri—Most of the northern and west-central portions of Missouri are underlain by rocks that are not conducive to water-bearing formations. They yield only small amounts of water, even during periods of normal and above-normal rainfall. Under drought conditions, adequate amounts of water cannot be pumped from the rock formations of northern Missouri to supply even domestic needs. Most streams in northern Missouri do not receive appreciable groundwater recharge. During periods of drought, these streams are generally reduced to a series of pools, or may become completely dry. Streams and water impoundments are the only localized sources of water during droughts, and even these limited resources are at risk when the drought is prolonged. Agriculture in west-central and northern Missouri is usually the first to feel the effects of drought. Although row-cropping is more

extensive in this part of the state, irrigation is generally not feasible except on the floodplains of major rivers.

Historical drought information for Missouri is difficult to find. However, a list of significant weather events in Missouri from the Missouri Climate Center during the twentieth century highlights droughts in 1901 (the second driest year on record with 25.86 inches of precipitation), the dustbowl years of the 1930s and 40s, the 1950s (this was drier than the dustbowl years), and 1988. According to the Missouri State Climatologist, the worst drought on record for southwestern Missouri occurred over a five year period between 1952 and 1956. With just 25.35 inches of precipitation, 1953 is Missouri's driest year on record. There is limited data available on droughts since the 1950's. Missouri has recently been under another dry spell that began in 1999. 2005 was the driest year in southwestern Missouri since 1980. Additionally, tree-ring research from scientists at the University of Missouri suggests that Missouri suffered a severe drought from 1548 to 1558. The tree-ring patterns also show that Midwest droughts have occurred on a regular 18.6-year cycle.

Drought of 1999–2000

Most of Missouri, along with other states, was in a drought condition during the last half of 1999. The dryness did not begin until July 1999, but rapidly developed into a widespread drought by September. At that time, Missouri was placed under a Phase I Drought Advisory level by the Department of Natural Resources (DNR), and Governor Carnahan declared an agricultural emergency for the entire state. Agricultural reporting showed a 50 percent crop loss from the drought in 50 counties, with severe damage to pastures for livestock, corn crops, and Missouri's top cash crop—soybeans. On October 13, 1999, Dan Glickman, USDA secretary declared all Missouri counties agricultural disaster areas, making low-interest loans available to farmers in Missouri and contiguous states. The drought intensity increased through autumn and peaked at the end of November 1999. In fact, the five-month span between July and November became the second driest July-November period in Missouri since 1895, averaging only 9.38 inches of rain.

A wetter-than-normal winter diminished dry conditions in central and southern Missouri, but long-term moisture deficits continued to exist. At the same time, the remainder of the state (roughly north of the Missouri River) continued under drought conditions. Overall dry conditions returned through much of the state in March 2000, and costly wildfires and brush fires (70) erupted in many counties. By May, the entire state was under a Phase II Drought Alert level, and on May 23, Governor Carnahan announced activation of the Missouri Drought Assessment Committee (DAC), made up of state and federal agencies and chaired by Jeff Staake the DNR deputy director. At a May 25, 2002, meeting, the DAC selected a subcommittee (guided by the Missouri Drought Response Plan) to determine the drought status of each county. In June, based on observations across the state and projections of future rainfall, the committee upgraded the drought status for 27 northern Missouri counties to Phase III Conservation. This was based on concerns for water supplies and agricultural impacts. The City of Milan in Sullivan County was among the most severely affected in terms of water supplies. In June, a total of 80 Missouri counties remained under the Phase II Alert level, while 7 counties in southeast Missouri (Butler,

Dunklin, Mississippi, New Madrid, Pemiscot, Scott, and Stoddard) remained under Phase I Advisory conditions.

By mid-July 2000, some areas of northern Missouri benefited from additional rainfall, while drier conditions prevailed in other areas. At its July 12 meeting, the DAC revised its assessment, placing 30 counties under Phase III Conservation conditions, including 10 counties in the south-central area. The remaining 84 counties in the state were under Phase II Drought Alert conditions. This included seven counties in northern Missouri, which were downgraded from Phase III Conservation, and seven counties in Southeast Missouri, which were previously assessed as Phase I Advisory.

To ease the agricultural impact of the drought during the summer months, Governor Carnahan gained release of over one million acres from the Conservation Reserve Program (CRP) to provide farmers and ranchers in 21 counties additional sources to cut hay for livestock feed. Also, livestock producers in 16 counties were released from CRP contracts to allow cattle grazing on certain idle lands.

Drought of 2002-2004

The drought of 2002 caused tremendous financial hardships to many Missouri crop and livestock producers. The financial impact of the drought on producers in turn impacted the local communities and the state in terms of reduced economic activity. This drought cost an estimated $46 million in 2002 and $575 million for 2003 in terms of Missouri's agricultural and economic productivity.

Drought conditions encompassed most of the northwestern quarter of Missouri. Severe drought conditions affected the northwest, west-central, and some portions of southwest Missouri, causing water conservation measures to be taken and restrictions to be imposed. For some areas, this was the second driest year since 1914. The only drier year was in 1988. 2002 had the driest November–December period on record for northwestern and north-central Missouri. The drought continued through 2003 and 2004 with conditions improving in 2004. As of March 3, 2004, drought conditions still encompassed most of the northwestern quarter of Missouri with 18 counties designated as being in Phase III Conservation. The drought conditions improved due to an increase in precipitation between March and June 2004. In June 2004, Missouri was considered drought-free for the first time in three years. Figures 3.11 through 3.13 illustrate the drought status on different dates in 2002, 2003, and 2004.

Figure 3.11. Drought Condition Status (August 13, 2002)

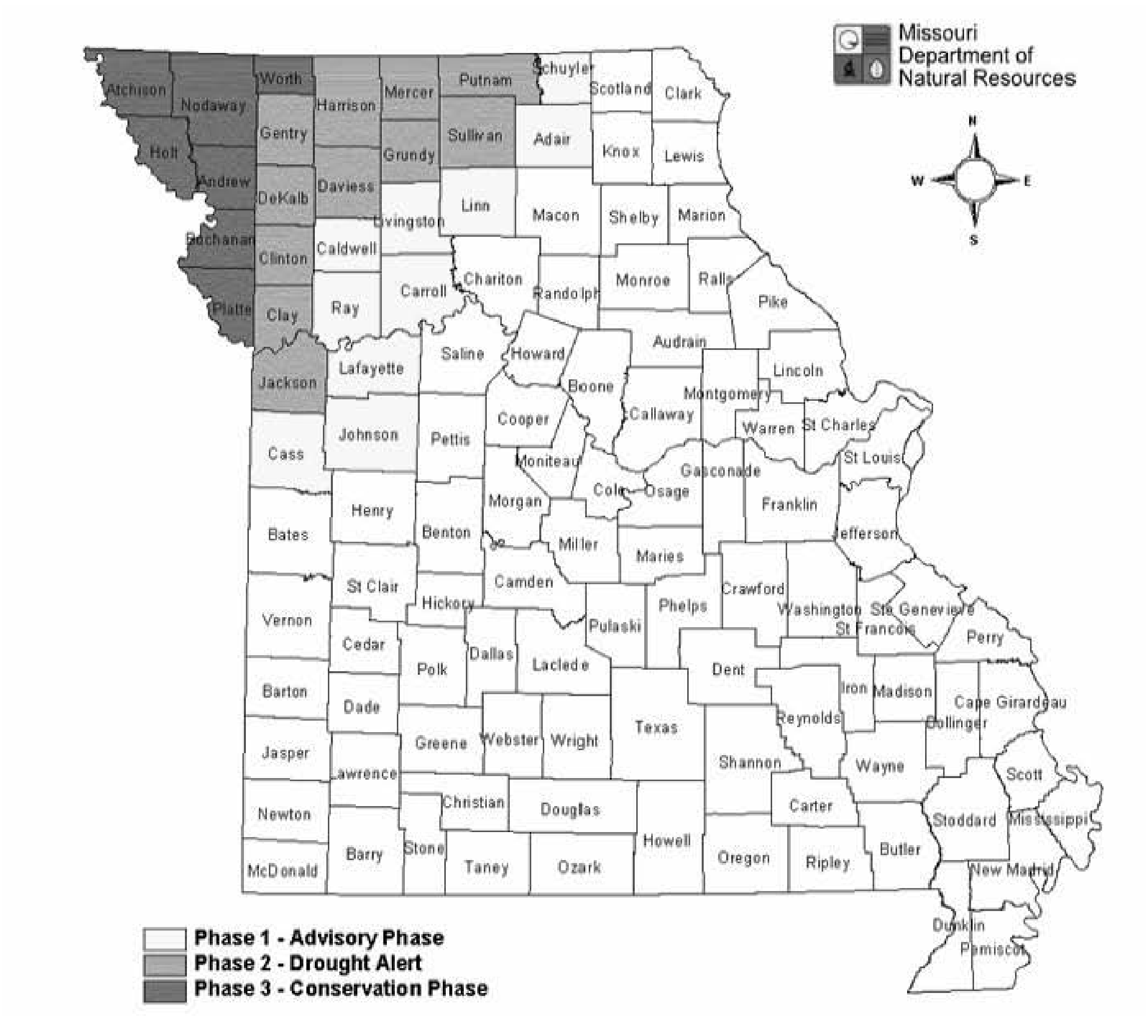


Figure 3.12. Drought Condition Status (July 29, 2003)

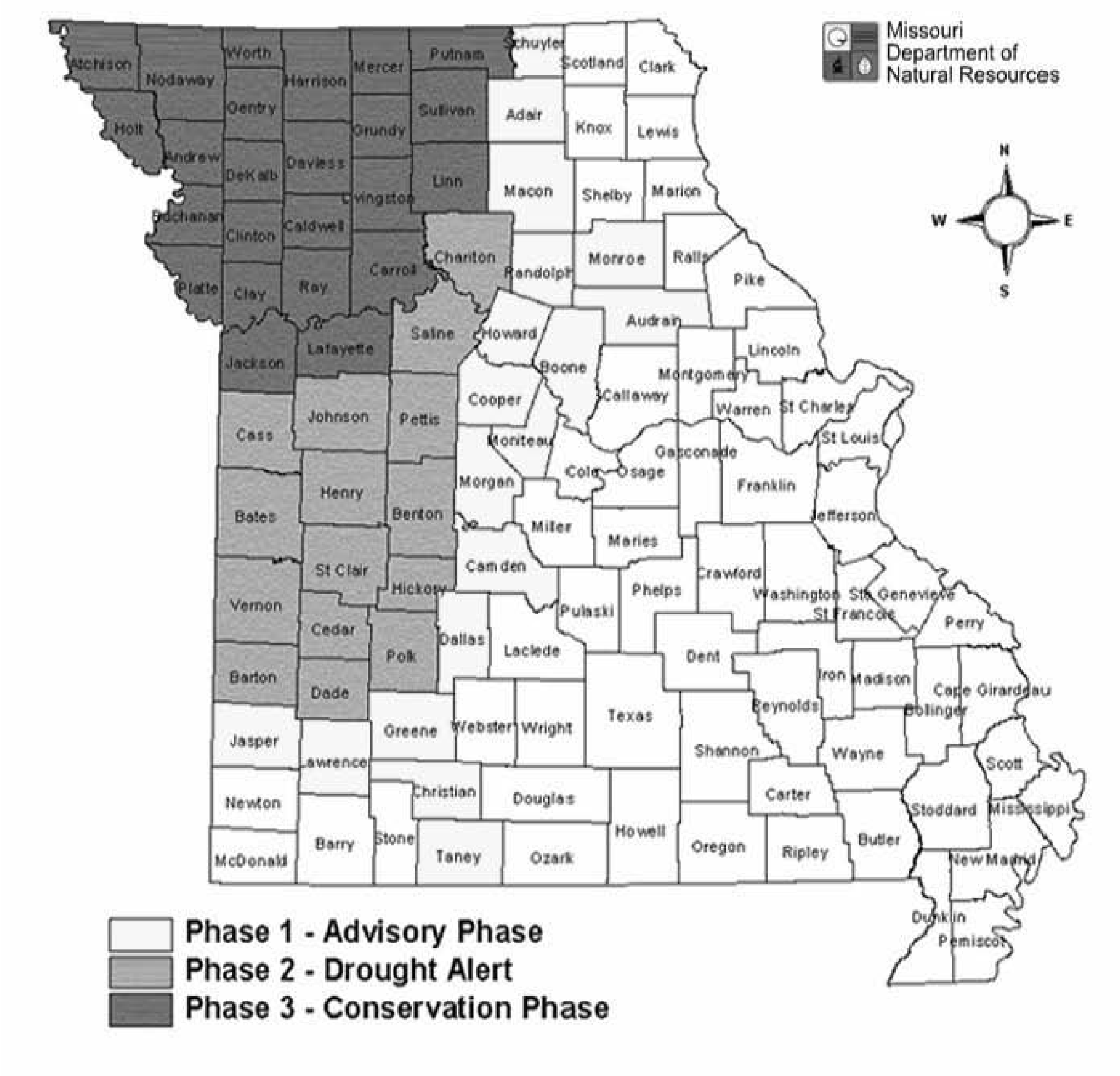
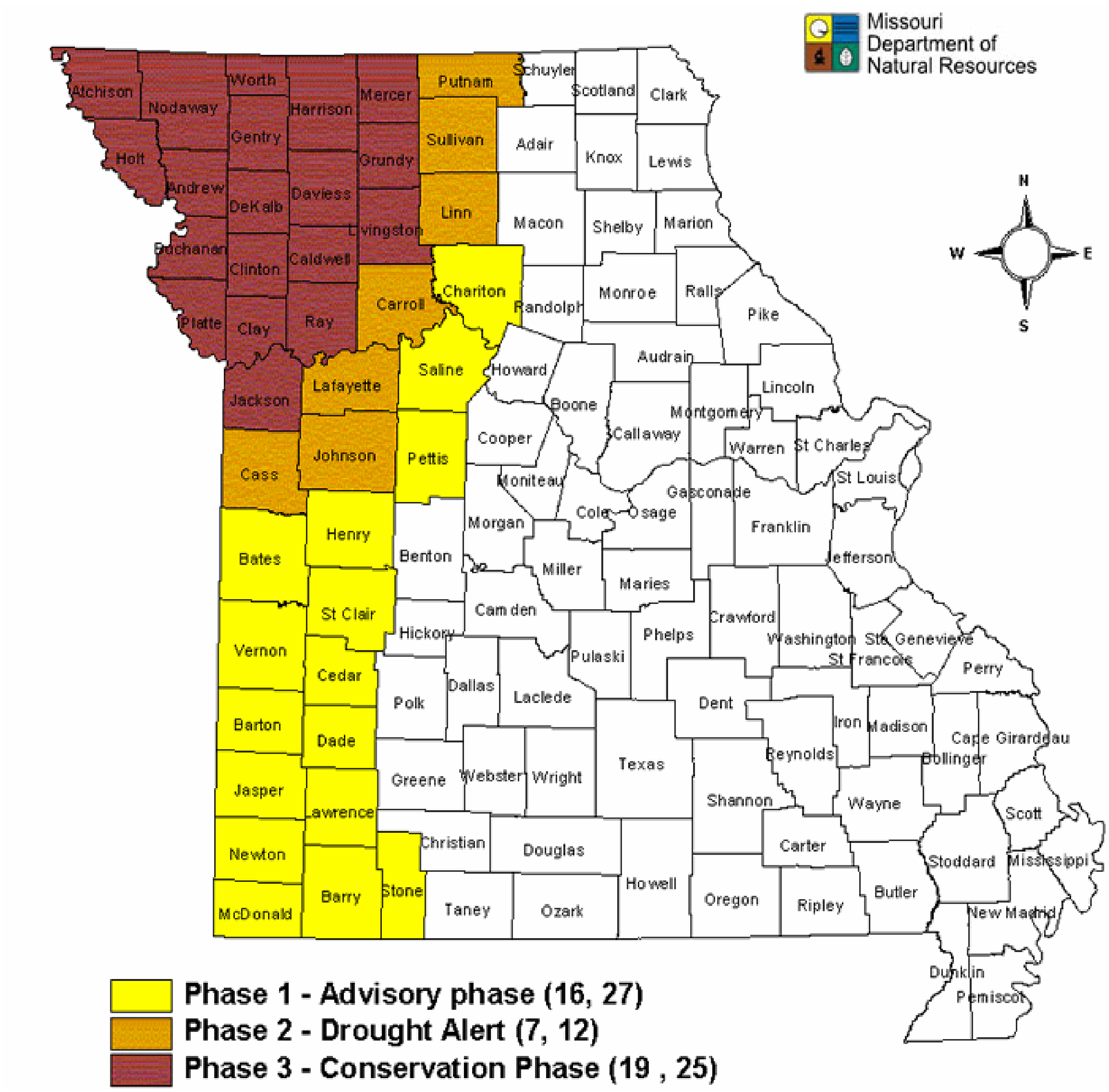


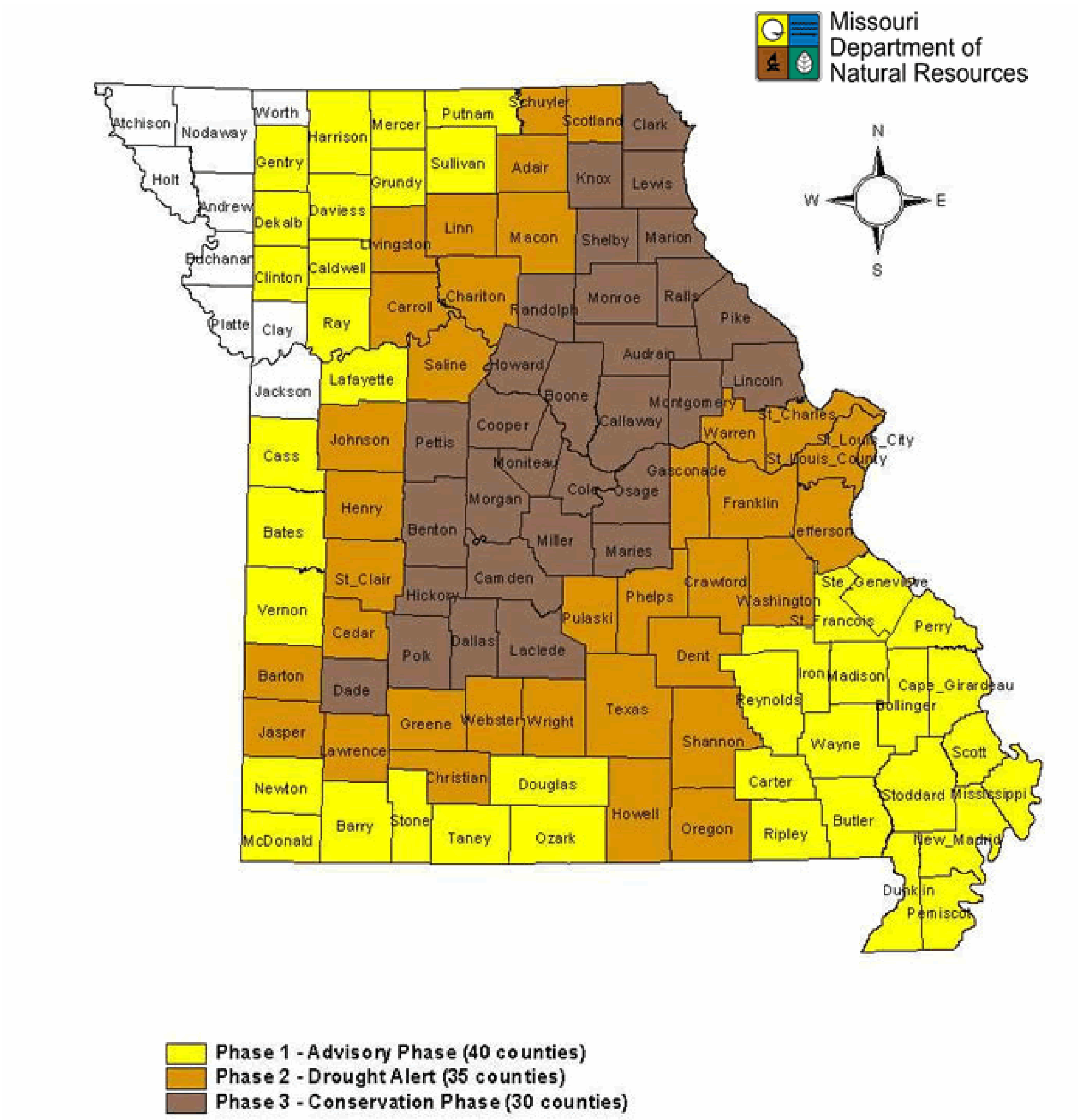
Figure 3.13. Drought Condition Status (January 13, 2004)



Drought of 2005

The drought of 2005, as in the previous drought of 2003-2004, caused tremendous hardships to many Missouri crop and livestock producers. According to the University of Missouri's Food and Agriculture Institute, the estimated losses to the corn and hay crops alone will likely top $370 million. For some Missouri farmers, this will be a drier year than 1988. By late July, the drought conditions encompassed all but nine counties in the northwestern corner of the state. Severe drought conditions affected counties in the southwest through the northeast part of the state. Effective August 23, 2005, due to the secretarial disaster designation, 114 Missouri counties and St. Louis City were designated as natural disasters for physical and/or production-loss loan assistance from Farm Service Agency (FSA). The drought conditions began to improve by late August and into September. Figure 3.14 illustrates the drought status in July 2005.

Figure 3.14. Drought Condition Status (July 29, 2005)



Drought of 2006

The drought of 2006 has had a tremendous agricultural impact on Missouri farmers. As of September 2006, FSA reported that 26 counties had requested Emergency Conservation Program (ECP) funds with 2 additional counties pending. The livestock industry is feeling severe effects from the current drought. Hay supplies are short, and water supplies for livestock continue to decline. USDA reported that the new $50 million program for livestock producers, called the Livestock Assistance Grant Program, will provide this money in Section 32 to states in block grant form. The drought has also had an impact on local water supplies with several communities issuing mandatory conservation measures.

The September 19, 2006, Interim Drought Status map (see Figure 3.15) indicated that only 10 counties in the southeastern portion of the state were free of drought. The November 28, 2006, map (see Figure 3.16) indicated that while 5 more counties were drought-free, 11 more had entered Phase III for a total of 49 counties in the Conservation Phase. In October 2006, the USDA designated 85 Missouri counties as a primary natural disaster area (and extended assistance eligibility to 20 contiguous counties) due to losses caused by the drought beginning January 1, 2006. Only the southeast corner and the extreme northwest corner were not eligible for assistance. According to Pat Guinan, University of Missouri climatologist, a snowstorm in late November/early December put a dent in the drought, but more rain and snow are needed for conditions to return to normal.

Figure 3.15. Interim Drought Status (September 19, 2006)

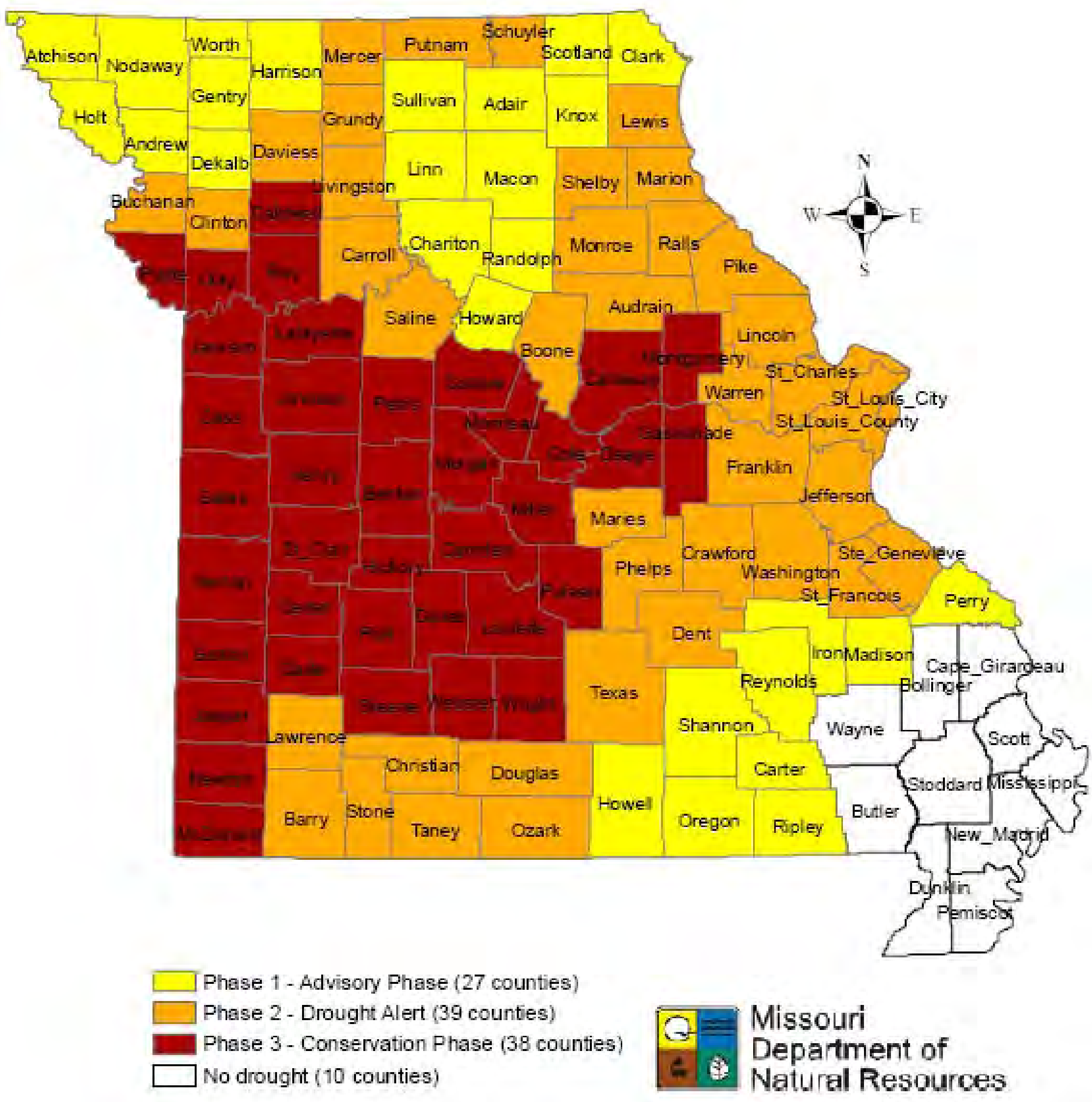
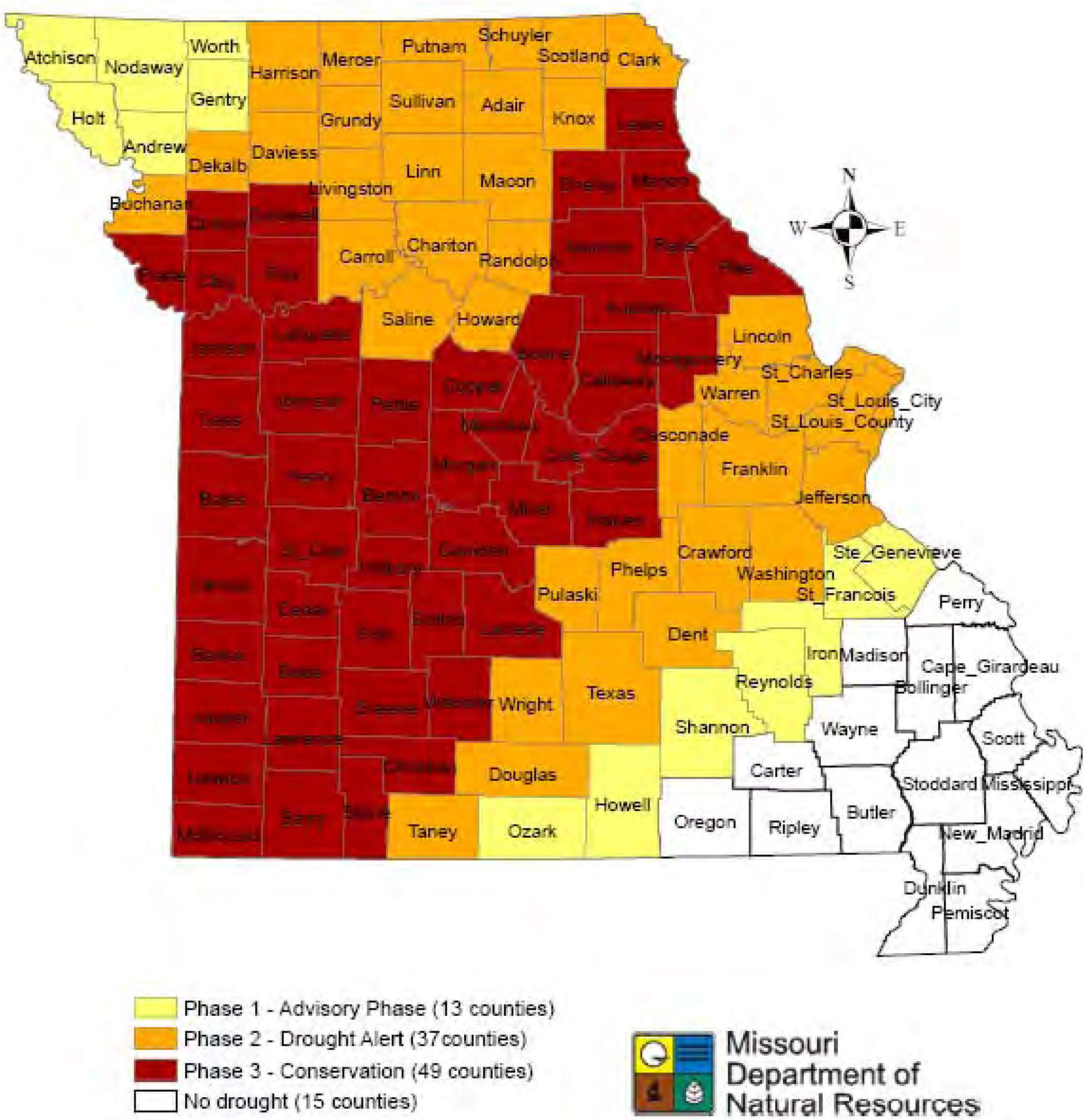


Figure 3.16. Interim Drought Status (November 28, 2006)



Measure of Probability and Severity

Probability: Moderate
Severity: Moderate

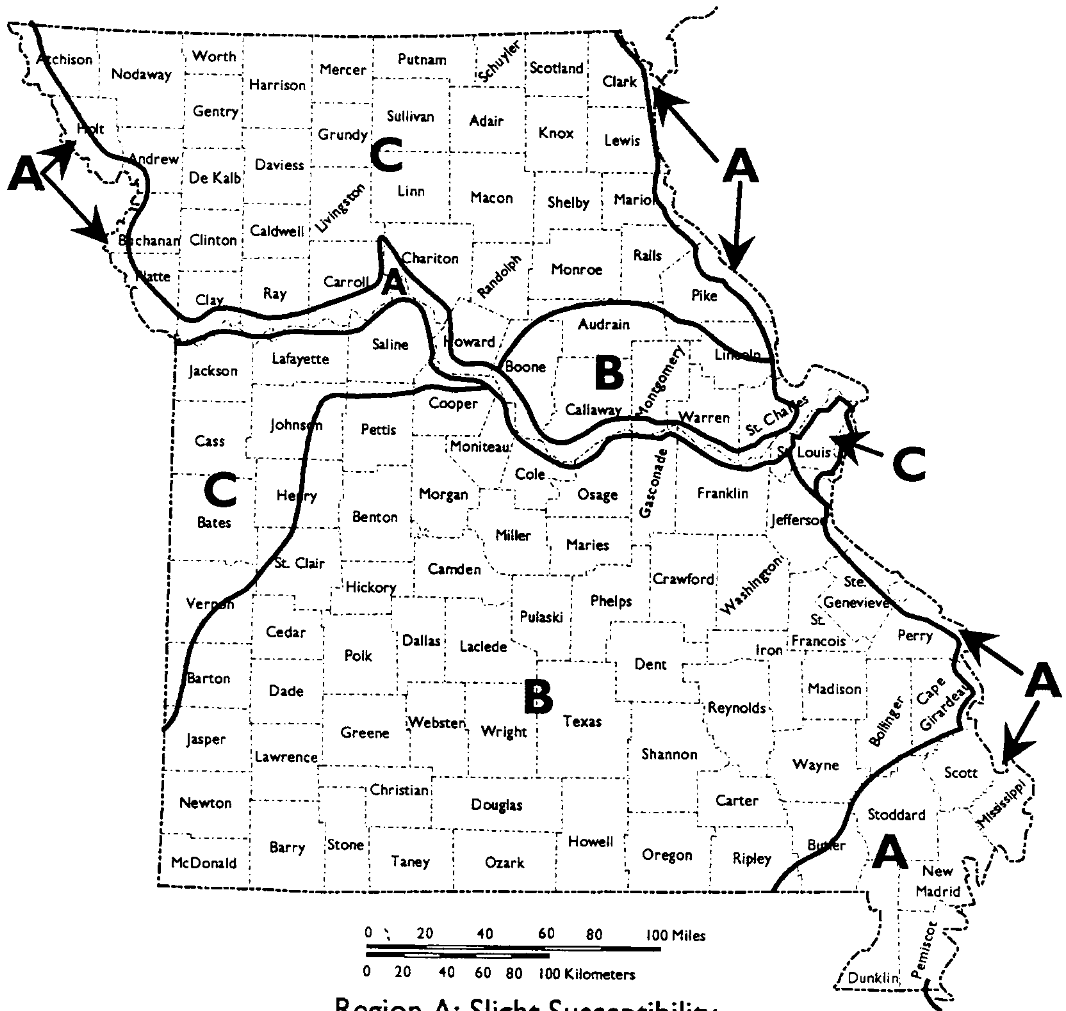
Because of its geographical location and characteristic weather patterns, Missouri is vulnerable to drought conditions. Agricultural droughts are the most common on record, particularly those inflicting damage to corn crop yields. Throughout much of this century, these droughts have occurred with common regularity (on the average of once every five years), according to the Missouri Crop and Livestock Reporting Service.

Based on Midwest drought data, the Missouri Department of Natural Resources (DNR) Water Resources Program produced a Missouri Drought Response Plan in 1995 with revisions in 2002 (now the Missouri Drought Plan). The plan's primary purpose is to address the need for state and local governments to coordinate advanced emergency planning, as during the drought of 1999–2000. The plan outlines proactive emergency and tactical measures designed to better prepare the state for drought. It also emphasizes the need for long-range strategic planning, which would address the bigger issue of drought impact avoidance. The plan notes that one of the major goals of drought mitigation is to prevent water shortages in the agricultural sector and public water systems.

The plan divides the state into three regions, which are prioritized according to drought susceptibility (see Figure 3.17). The regions are identified as having slight, moderate, and severe susceptibility to drought conditions. Descriptions of drought susceptibility for the three regions are as follows:

- **Region A (mostly southeast Missouri)** has very little drought susceptibility. It is a region underlain by sands and gravel (alluvial deposits). Surface and groundwater resources are generally adequate for domestic, municipal, and agricultural needs.
- **Region B (central, east-central Missouri)** has moderate drought susceptibility. Groundwater resources are adequate to meet domestic and municipal water needs, but due to required well depths, irrigation wells are very expensive. The topography is generally unsuitable for row-crop irrigation.
- **Region C (northern, west-central Missouri; St. Louis County)** has severe drought vulnerability. Surface water sources usually become inadequate during extended drought. The groundwater resources are normally poor, and typically supply enough water only for domestic needs. Irrigation is generally not feasible. When irrigation is practical, groundwater withdrawal may affect other uses. Surface water sources are used to supplement irrigation supplied by groundwater sources.

Figure 3.17. Drought Susceptibility



Region A: Slight Susceptibility
Region B: Moderate Susceptibility
Region C: High Susceptibility

The Missouri Drought Plan relies primarily upon the PDSI to indicate drought severity and supports its findings directly with stream flow, reservoir-level, and groundwater-level measurements. Actions within the drought plan are triggered when the PDSI reaches certain levels. The DAC, chaired by the director (or designee) of the DNR, is activated in the Phase II Drought Advisory stage. The DAC then activates the impact teams, which cover the topics of agriculture, natural resources and environmental recreation, water supplies, wastewater and health, social, economic, and postdrought evaluations. Areas that appear to be the most vulnerable to drought are the focus of future drought planning, management, and mitigation activities. Based on this information, the state rates the probability and severity of the drought hazard as moderate.

Impact of the Hazard

A severe drought in the Southern Plains states from the fall of 1995 through the summer of 1996 resulted in more than $1 billion in costs and damage to agricultural regions. The states of Texas and Oklahoma were most severely affected. In the summer of 1993, a combination of drought and a heat wave across the southeast United States was responsible for about $1 billion in costs and damage. Among the most costly disasters, however, was the Great Drought of 1988–1989, which caused an estimated $39 billion in losses in the United States. As a comparison, the record floods of 1993 in the Midwest inflicted damage in the range of $12 to $16 billion. Although more subtle in terms of physical damage, the social and economic costs of drought are substantial.

Drought, as it affects the health and safety of Missouri citizens, is primarily a problem of rural water supply. With some exceptions, larger municipalities have not experienced major problems at levels that have caused impacts to some smaller communities. Most seriously affected are those supplied by small water structures. In its scope, a drought may be limited to a localized problem, or even a regional problem. Based on severity and duration, it may even become a statewide problem, at least in terms of overall impact, such as the commitment and shifting of resources and other response issues. Good water quality and a plentiful supply are two factors that we often take for granted. But when good water becomes a scarce commodity and people must compete for the available supply, the importance of these two factors increases dramatically. Missouri's Resources Plan (*RSMo 640.415*), which is a provision of the Water Resources Law enacted by the Missouri Legislature in 1989, requires DNR to ensure that the quality and quantity of Missouri's water resources are maintained at the highest possible level to support present and future beneficial uses. The provision was established to provide for the development, maintenance, and periodic updating of a long-range comprehensive statewide plan for the use of surface water and groundwater. It includes existing and future requirements for drinking water supplies, agriculture, industry, recreation, environmental protection, and related needs.

The information in Table 3.12 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.12. EMAP Impact Analysis: Drought

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Most damage expected to be agricultural in nature. However, water supply disruptions may adversely affect people.
Health and Safety of Personnel Responding to the Incident	Nature of hazard expected to minimize any serious damage to properly equipped and trained personnel.
Continuity of Operations	Unlikely to necessitate execution of the Continuity of Operations Plan.
Property, Facilities, and Infrastructure	Nature of hazard expected to minimize any serious damage to facilities.
Delivery of Services	Nature of hazard expected to minimize serious damage to services, except for moderate impact on water utilities.
The Environment	May cause disruptions in wildlife habitat, increasing interface with people, and reducing numbers of animals.
Economic and Financial Condition	Local economy and finances dependent on abundant water supply adversely affected for duration of drought.
Regulatory and Contractual Obligations	Regulatory waivers unlikely, but permits expedited. Fulfillment of some contracts may be difficult. Impact may reduce deliveries.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

In addition to damage to crops, produce, livestock, and soil, and the resulting economic consequences, the arid conditions created by drought pose an increased risk of fire. The danger is especially high for brush fires, grass fires, and fires in wooded areas, which can threaten homes and other structures in their path. Lack of water resources in rural areas can complicate the firefighting efforts. During the spring 2000 drought, brush and wildfires erupted in numerous counties, resulting in a governor’s declared state of emergency and a presidential Fire Management Assistance declaration. The fires in Camden County were the most severe (see Section 3.2.4 Fires).

Severe drought also poses health threats to citizens due to water shortages and extreme heat. Particularly vulnerable are children, the elderly, and those with respiratory problems. Contaminated or poor water quality for drinking and sanitation measures can also cause serious

illnesses. The Missouri Drought Plan addresses issues regarding water shortages and can be accessed via the DNR web site at www.MDNR.mo.state.mo.gov/.

3.2.3. Earthquakes

Description of Hazard

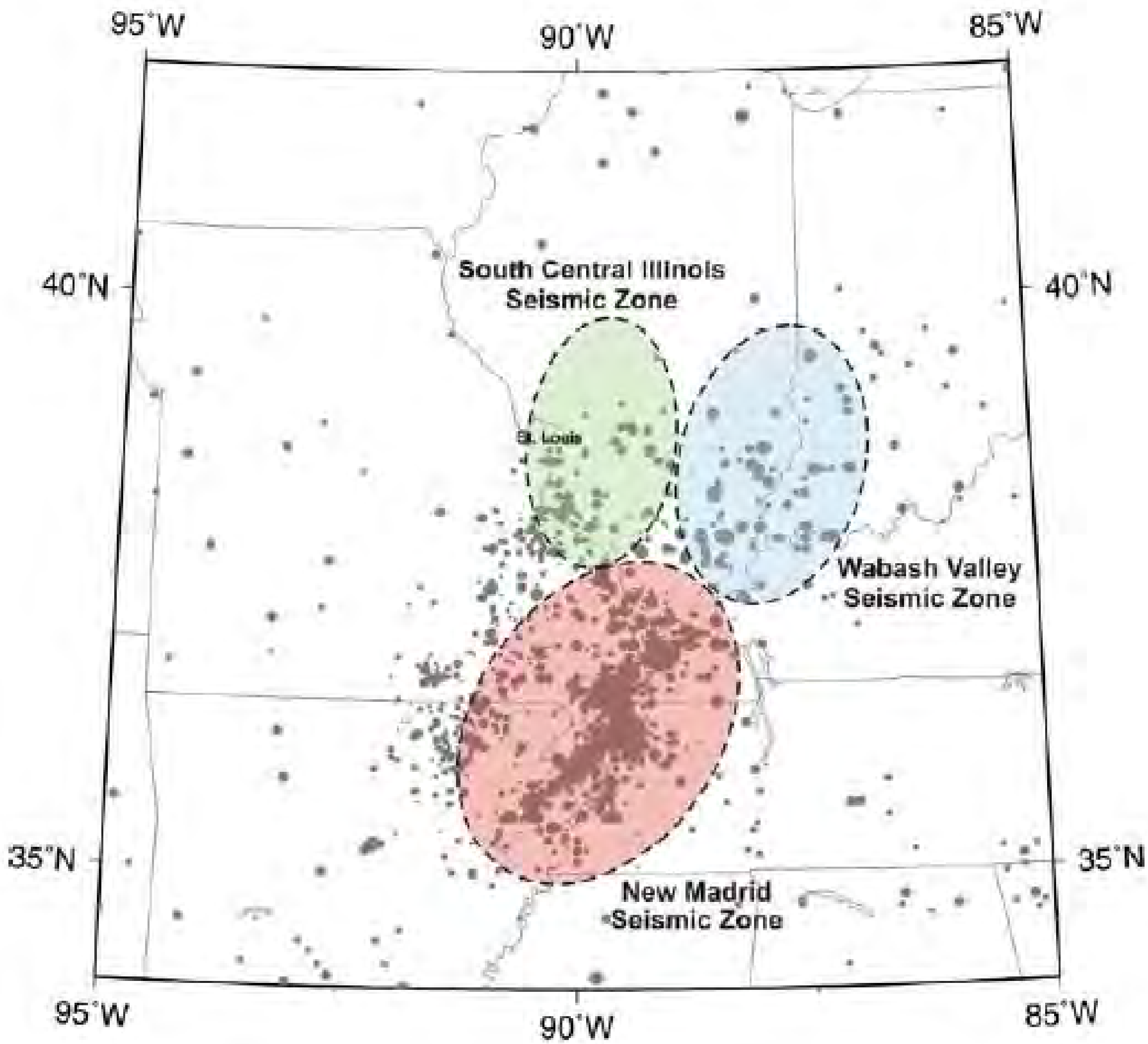
Earthquakes are defined as shifts in the earth's crust causing the surface to become unstable. This instability can manifest itself in intensity from slight tremors to large shocks. The duration can be from a few seconds up to five minutes. The period of tremors (and shocks) can last up to several months. The larger shocks can cause ground failure, landslides, liquefaction, uplifts, and sand blows.

The earth's crust is made up of gigantic plates, commonly referred to as tectonic plates. These plates form what is known as the lithosphere, which varies in thickness from 6.5 miles (beneath oceans) to 40 miles (beneath mountain ranges), and has an average thickness of 20 miles. These plates "float" over a partly melted layer of crust called the asthenosphere. The plates are in motion, and areas where one plate joins another are referred to as "plate boundaries." Areas where the plates are moving toward each other are called convergent plate boundaries, and areas where they are moving away from each other are called divergent plate boundaries. The San Andreas Fault in California is a horizontal motion boundary where the Pacific Plate is moving to the north while the North American Plate is moving to the west. These movements release built-up energy in the form of earthquakes, tremors, and volcanic activity. Fault lines such as the San Andreas come all the way to the surface and can be readily seen and identified. Some fault lines do not come all the way to the surface, yet they can store and release energy when they move. Many of the faults in the central United States are characterized this way.

The subterranean faults were formed many millions of years ago on or near the surface of the earth. Subsequent to that time, these ancient faults subsided, while the adjacent areas were pushed up. As this fault zone (also known as a rift) lowered, sediments filled in the lower areas. Under pressure, sediments hardened into limestones, sandstones, and shales, thus burying the rifts. With the pressure on the North Atlantic Ridge affecting the eastern side of the North American Plate, and the movements along the San Andreas Fault by the Pacific Plate, the buried rift system in the Mississippi embayment has been reactivated. This particular rift system is now called the Reelfoot Rift.

Eight earthquake seismic zones are located in the central United States, two of which are located in Missouri. The most active zone is the New Madrid Seismic Zone, which is also the most active seismic area in the United States east of the Rocky Mountains and, according to the U.S. Geological Survey, is by some measures as high a hazard as seismic zones in California. It runs from northern Arkansas through southeast Missouri and western Tennessee and Kentucky to the Illinois side of the Ohio River Valley (see Figure 3.18).

Figure 3.18. New Madrid, South Central Illinois, and Wabash Valley Seismic Zones



Source: Rogers, Karadeniz, and Cramer (in press 2007)

The southeastern (Bootheel) section of Missouri is most susceptible to earthquakes because it overlies the New Madrid Seismic Zone. It is at risk to strong ground motions and has a high potential for soil liquefaction due to the presence of sandy, loosely consolidated sediments and a high water table. The immediate vicinity of the Ozarks is also at risk from earthquakes in the New Madrid Seismic Zone because, like in the Bootheel, subsurface conditions of the Mississippi and Missouri river valleys tend to amplify earthquake ground shaking. Earthquake hazards in the western part of the state also exist because of the historical earthquakes in eastern Kansas and Nebraska. No area of Missouri is immune from the danger of earthquakes. Minor, but potentially damaging, earthquakes can occur anywhere in the state.

In addition to the New Madrid Seismic Zone, other seismic zones that affect Missourians include the Wabash Valley Seismic Zone, the South Central Illinois Seismic Zone, and the Nemaha Uplift. The Wabash and Illinois seismic zones are not as active as the New Madrid Seismic Zone based on microseismic activity, but they are considered capable of producing earthquakes in the range of M 6.0 to 6.8. An earthquake of this magnitude on the South Central Illinois Seismic Zone could potentially cause more damage to the St. Louis metropolitan area than a New Madrid Seismic Zone event because it is closer to the area. The Nemaha Uplift is of concern to Missourians because it runs parallel to the Missouri/Kansas border from Lincoln, Nebraska, to Oklahoma City, Oklahoma. Earthquakes from the Nemaha Uplift are not as severe as those associated with the historic New Madrid Seismic Zone. Several earthquakes have affected Missouri in the past.

Large earthquakes in Missouri could trigger additional hazards such as soil liquefaction, lateral spreading, landslides, and sinkhole collapse (specifically in the karst topography present in much of southeast Missouri). Liquefaction is a site soil response to strong earthquake ground motion. Strong earthquake waves cause water pressure to increase within sandy soils; force sand grains apart, and the material will behave as a dense liquid. Sandblows form in the areas where liquefied sand is overlain by heavier clay rich silts, causing a geyser-like eruption of sand onto the land surface. Liquefaction causes land to lose its load-bearing capacity, which can lead to differential settlement and associated building foundation failures. Lateral spreading can occur even on gentle slopes and seriously damage buried utilities and road networks. Landslides could be triggered in steep slopes and road cuts through unstable geologic materials, potentially damaging and closing roads and railroads. Earthquake shaking will exacerbate existing problems and cause even more slides where none have existed before. It is possible that housing developments on certain shale bedrock units could be affected by landslides as well, with potentially catastrophic results.

Historical Statistics

Small earthquakes occur often in Missouri. About 200 are detected every year in the New Madrid Seismic Zone. Most can only be detected by sensitive instruments, but southeast Missouri experiences an earthquake once or twice every 18 months that is strong enough to crack plaster in buildings.

The most severe earthquakes occurred in the New Madrid Seismic Zone during a period between December 16, 1811, and March 12, 1812. The earthquakes on December 16, 1811, and February 7, 1812, rank number seven and nine respectively among the United States' largest earthquakes. An engineer in Louisville, Kentucky, counted over 1,850 shocks during this time, including three earthquakes of magnitude greater than 8.3 (Richter magnitude). The shocks from these earthquakes could be easily felt as far away as Detroit, Michigan, and Charleston, South Carolina. The area between the St. Francois River and Mississippi River south of New Madrid to Marked Tree, Arkansas, showed numerous sand blows from liquefaction.

Areas uplifted as well as subsided (dropped) along the Mississippi River. For instance, the area around Tiptonville, Tennessee, formed a dome (uplift of several yards). Immediately adjacent to the Tiptonville Dome, an area subsided to form a lake 18 miles long and 5 miles wide. It is now known as Reelfoot Lake and is a tourist and recreation area. Ground failure and landslides were apparent throughout the bluffs (Chickasaw Bluffs) alongside the Mississippi River in Kentucky and Tennessee. Many fissures were made throughout the region, and one local observer recorded that the earth seemed to be rolling in waves a few feet in height. These swells would burst, leaving wide and long fissures. The damage to the area was so severe that Congress passed, and President James Madison signed into law, the first disaster relief act, giving government lands in other territories to people wanting to move out of the area.

The following is excerpted directly from Carl A. von Hake's "Missouri Earthquake History" in Earthquake Information Bulletin, Volume 6, Number 3, May–June 1974:

> Whatever the seismic history of the region may have been before the first Europeans arrived, after December 16, 1811, there could be no doubt about the area's potential to generate severe earthquakes. On that date, shortly after 2 AM, the first tremor of the most violent series of earthquakes in the United States history struck southeast Missouri. In the small town of New Madrid, about 290 kilometers south of St. Louis, residents were aroused from their sleep by the rocking of their cabins, the cracking of timbers, the clatter of breaking dishes and tumbling furniture, the rattling of falling chimneys, and the crashing of falling trees. A terrifying roaring noise was created as the earthquake waves swept across the ground. Large fissures suddenly opened and swallowed large quantities of river and marsh water. As the fissures closed again, great volumes of mud and sand were ejected along with the water.
>
> The earthquake generated great waves on the Mississippi River that overwhelmed many boats and washed others high upon the shore. The waves broke off thousands of trees and carried them into the river. High river banks caved in, sand bars gave way, and entire islands disappeared. The violence of the earthquake was manifested by great topographic changes that affected an area of 78,000 to 130,000 square kilometers.
>
> On January 23, 1812, a second major shock, seemingly more violent than the first, occurred. A third great earthquake, perhaps the most severe of the series, struck on February 7, 1812.
>
> The three main shocks probably reached intensity XII, the maximum on the Modified Mercalli scale, although it is difficult to assign intensities, due to the scarcity of settlements at the time. Aftershocks continued to be felt for several years after the initial tremor. Later evidence indicates that the epicenter of the first earthquake (December 16, 1811) was probably in northeast Arkansas. Based on

historical accounts, the epicenter of the February 7, 1812, shocks was probably close to the town of New Madrid.

Although the death toll from the 1811-12 series of earthquakes has never been tabulated, the loss of life was very slight. It is likely that if at the time of the earthquakes the New Madrid area had been as heavily populated as at present, thousands of persons would have perished. The main shocks were felt over an area covering at least 5,180,000 square kilometers. Chimneys were knocked down in Cincinnati, Ohio, and bricks were reported to have fallen from chimneys in Georgia and South Carolina. The first shock was felt distinctly in Washington, D.C., 700 miles away, and people there were frightened badly. Other points that reported feeling this earthquake included New Orleans, 804 kilometers away; Detroit, 965 kilometers away; and Boston, 1,769 kilometers away.

The New Madrid seismic zone has experienced numerous earthquakes since the 1811-12 series, and at least 35 shocks of intensity V or greater have been recorded in Missouri since 1811. Numerous earthquakes originating outside of the state's boundaries have also affected Missouri. Five of the strongest earthquakes that have affected Missouri since the 1811-12 series are described below.

On January 4, 1843, a severe earthquake in the New Madrid area cracked chimneys and walls at Memphis, Tennessee. One building reportedly collapsed. The earth sank at some places near New Madrid; there was an unverified report that two hunters were drowned during the formation of a lake. The total felt area included at least 1,036,000 square kilometers.

The October 31, 1895, earthquake near Charleston, Missouri, probably ranks second in intensity to the 1811-12 series. Every building in the commercial area of Charleston was damaged. Cairo, Illinois, and Memphis, Tennessee, also suffered significant damage. Near Charleston, 4 acres of ground sank and a lake was formed. The shock was felt over all or portions of 23 states and at some places in Canada.

A moderate earthquake on April 9, 1917, in the Ste. Genevieve–St. Mary's area was reportedly felt over a 518,000 square kilometer area from Kansas to Ohio and Wisconsin to Mississippi. In the epicentral area people ran into the street, windows were broken, and plaster cracked. A second shock of lesser intensity was felt in the southern part of the area.

The small railroad town of Rodney, Missouri, experienced a strong earthquake on August 19, 1934. At nearby Charleston, windows were broken, chimneys were overthrown or damaged, and articles were knocked from shelves. Similar effects were observed at Cairo, Mounds and Mound City, Illinois, and at Wickliff,

Kentucky. The area of destructive intensity included more than 596 square kilometers.

The November 9, 1968, earthquake centered in southern Illinois was the strongest in the central United States since 1895. The magnitude 5.5 shock caused moderate damage to chimneys and walls at Hermann, St. Charles, St. Louis, and Sikeston, Missouri. The felt areas include all or portions of 23 states.

Mostly recently along Nemaha Seismic Zone, an earthquake of 3.1 Richter magnitude occurred on March 31, 1993, close to the Cooper Nuclear Power Station in Brownville, Nebraska. No damage resulted, but the earthquake was felt across the Missouri River near Rock Port, Missouri. See Table 3.13 for a list of moderate/large earthquakes in the Central United States.

Table 3.13. Moderate/Large Earthquakes in the Central United States

Date	Locality	Magnitude	Maximum Intensity	Source Zone
December 16, 1811	New Madrid, Missouri	8.6	XII	New Madrid Fault
January 23, 1812	New Madrid, Missouri	8.0	XII	New Madrid Fault
February 7, 1812	New Madrid, Missouri	8.0	XII	New Madrid Fault
June 9, 1838	Southern Illinois	5.7	VI	Illinois Basin
January 4, 1843	Western Tennessee	6.3	VIII	New Madrid Fault
Unknown, 1860	Central Minnesota	5.0	Unknown	Colorado Lineament
August. 17, 1865	Southeastern Missouri	5.3	VII	New Madrid Fault
April 24, 1867	Lawrence, Kansas	5.1	VII	Nemaha Uplift
June 18, 1875	Western Ohio	5.3	VII	Cincinnati Arch
November 15, 1877	Eastern Nebraska	5.0	VII	Nemaha Uplift
October 22, 1882	Arkansas, Texas	5.5	VI–VII	Ouchita, Wichita Fault
July 26, 1891	Illinois, Indiana	5.9	VI	Wabash Valley Fault
October 31, 1895	Charleston, Missouri	6.7	VIII	New Madrid Fault
May 26, 1909	Illinois	5.1	VII	Cincinnati Arch
April 9, 1917	Eastern Missouri	5.0	VI	St. Francois Uplift
March 8, 1937	Western Ohio	5.0	VII–VIII	Cincinnati Arch
April 9, 1952	Enid, Oklahoma	5.1	VII	Nemaha Uplift
November 9, 1968	South Central Illinois	5.5	VII	Wabash Valley Fault
March 24, 1976	Marked Tree, Arkansas	5.0	V–VI	New Madrid Fault
July 27, 1980	North Central Kentucky	5.2	VII	Cincinnati Arch
January 31, 1986	Anna, Ohio	5.0	VI	Cincinnati Arch
June 9, 1987	Lawrenceville, Illinois	5.2	V–VI	Wabash Valley Fault
September 26, 1990	Chaffee, Missouri	3.0	IV–V	New Madrid Fault
May 3, 1991	Risco, Missouri	4.6	IV–V	New Madrid Fault
June 26, 2000	Harrison, Arkansas	3.9	VIII	Ouchita, Wichita Fault
December 7, 2000	Evansville, Indiana	3.9	V	Wabash Valley Fault
May 4, 2001	Conway, Arkansas	4.4	VI	Ouchita, Wichita Fault
February 8, 2002	Lewton, Oklahoma	3.9	V	Nemaha Uplift

Date	Locality	Magnitude	Maximum Intensity	Source Zone
June 18, 2002	Evansville, Indiana	4.6	VI	Wabash Valley Fault
November 3, 2002	O’Neill, Nebraska	4.3	V	Nemaha Uplift
June 6, 2003	Cairo, Illinois	4.0	VI	New Madrid Fault
August 16, 2003	West Plains, Missouri	4.0	V	New Madrid Fault
June 15, 2004	Sikeston, Missouri	3.7	V	New Madrid Fault
June 28, 2004	Ottawa, Illinois	4.2	VI	Illinois Basin
September 17, 2004	Middlesboro, Kentucky	3.7	V	New Madrid Fault
February 10, 2005	Blytheville, Arkansas	4.1	V	New Madrid Fault
May 1, 2005	Blytheville, Arkansas	4.1	V	New Madrid Fault
June 2, 2005	Dyersburg, Tennessee	4.0	IV	New Madrid Fault
August 24, 2005	Greeneville, Tennessee	3.7	IV	New Madrid Fault
January 2, 2006	Harrisburg, Illinois	3.6	II–III	Wabash Valley Fault
October 18, 2006	Lilborn, Missouri	3.4	IV	New Madrid Fault

Measure of Probability and Severity

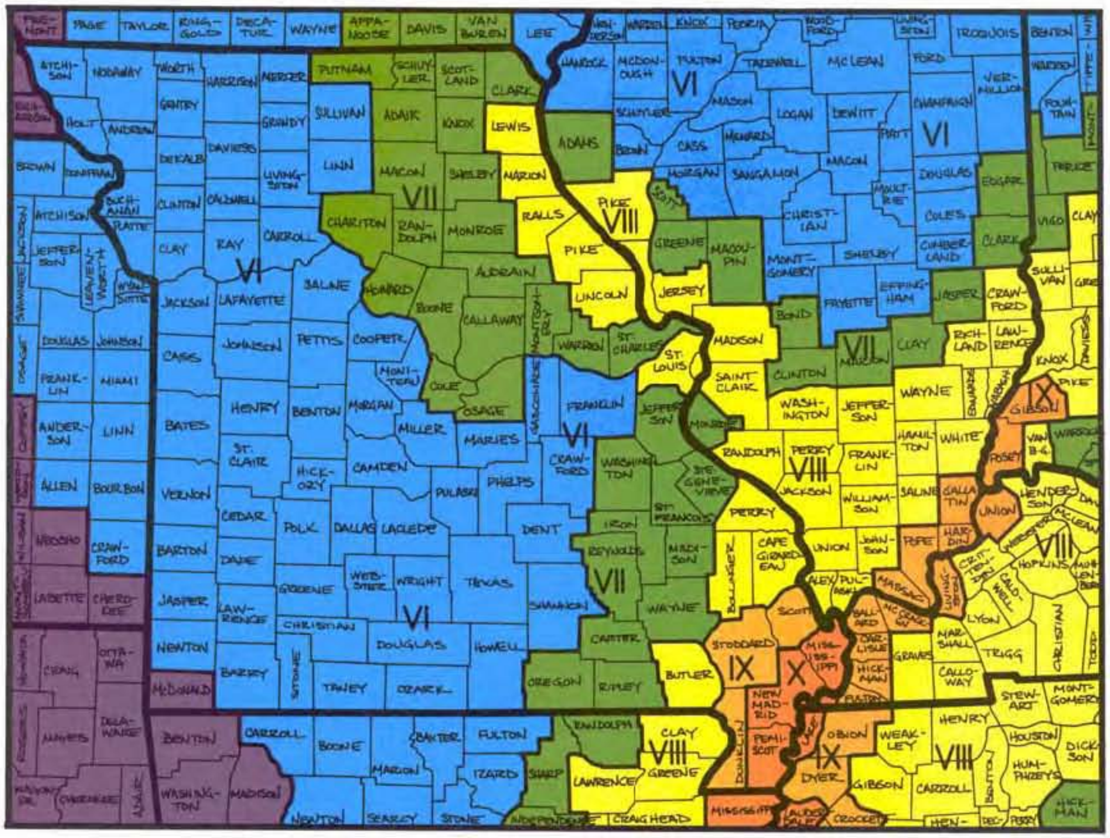
Probability: High
Severity: High

According to the U.S. Geological Survey and the Center for Earthquake Research and Information (CERI) at the University of Memphis, the probability of a repeat of the 1811–1812 earthquakes (magnitude 7.5–8.0) is 7 to 10 percent and the probability of a magnitude 6.0 or larger earthquake is 25 to 40 percent for a 50-year time period. A damaging earthquake 6.0 or greater) in the New Madrid Seismic Zone occurs about every 80 years (the last one was the Charleston event in 1895).

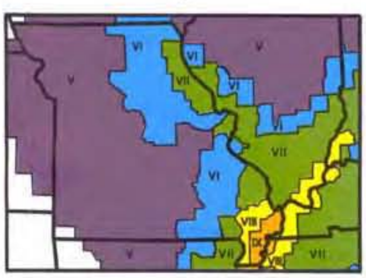
With approximately 12.5 million people living in the area, steps are being taken to reduce related hazards to citizens and property in the area. The probability of an earthquake increases with each day, which makes it difficult to rate. Based on the information from CERI, the probability of an earthquake is rated as moderate, and the severity is rated as high.

The map in Figure 3.19 shows the highest projected Modified Mercalli intensities by county from a potential magnitude 7.6 earthquake whose epicenter could be anywhere along the length of the New Madrid Seismic Zone. The secondary maps show the same regional intensities for a 6.7 and an 8.6 earthquake, respectively. Figure 3.20 describes the projected earthquake intensities for each level of the Modified Mercalli Intensity Scale.

Figure 3.19. Projected Earthquake Intensities



This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude – 7.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.



This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude – 6.7 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.

This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude – 8.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.

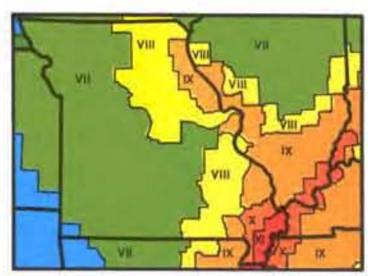


Figure 3.20. Modified Mercalli Intensity Scale

I People do not feel any Earth movement.

II A few people might notice movement.

III Many people indoors feel movement. Hanging objects swing.

IV Most people indoors feel movement. Dishes, windows, and doors rattle. Walls and frames of structures creak. Liquids in open vessels are slightly disturbed. Parked cars rock.

V Almost everyone feels movement. Most people are awakened. Doors swing open or closed. Dishes are broken. Pictures on the wall move. Windows crack in some cases. Small objects move or are turned over. Liquids might spill out of open containers.

VI Everyone feels movement. Poorly built buildings are damaged slightly. Considerable quantities of dishes and glassware, and some windows are broken. People have trouble walking. Pictures fall off walls. Objects fall from shelves. Plaster in walls might crack. Some furniture is overturned. Small bells in churches, chapels and schools ring.

VII People have difficulty standing. Considerable damage in poorly built or badly designed buildings, adobe houses, old walls, spires and others. Damage is slight to moderate in well-built buildings. Numerous windows are broken. Weak chimneys break at roof lines. Cornices from towers and high buildings fall. Loose bricks fall from buildings. Heavy furniture is overturned and damaged. Some sand and gravel stream banks cave in.

VIII Drivers have trouble steering. Poorly built structures suffer severe damage. Ordinary substantial buildings partially collapse. Damage slight in structures especially built to withstand earthquakes. Tree branches break. Houses not bolted down might shift on their foundations. Tall structures such as towers and chimneys might twist and fall. Temporary or permanent changes in springs and wells. Sand and mud is ejected in small amounts.

IX Most buildings suffer damage. Houses that are not bolted down move off their foundations. Some underground pipes are broken. The ground cracks conspicuously. Reservoirs suffer severe damage.

X Well-built wooden structures are severely damaged and some destroyed. Most masonry and frame structures are destroyed, including their foundations. Some bridges are destroyed. Dams are seriously damaged. Large landslides occur. Water is thrown on the banks of canals, rivers, and lakes. Railroad tracks are bent slightly. Cracks are opened in cement pavements and asphalt road surfaces.

XI Few if any masonry structures remain standing. Large, well-built bridges are destroyed. Wood frame structures are severely damaged, especially near epicenters. Buried pipelines are rendered completely useless. Railroad tracks are badly bent. Water mixed with sand, and mud is ejected in large amounts.

XII Damage is total, and nearly all works of construction are damaged greatly or destroyed. Objects are thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move. Lakes are dammed, waterfalls formed and rivers are deflected.

Intensity is a numerical index describing the effects of an earthquake on the surface of the Earth, on man, and on structures built by man. The intensities shown in these maps are the highest likely under the most adverse geologic conditions. There will actually be a range in intensities within any small area such as a town or county, with the highest intensity generally occurring at only a few sites. Earthquakes of all three magnitudes represented in these maps occurred during the 1811 - 1812 "New Madrid earthquakes." The isoseismal patterns shown here, however, were simulated based on actual patterns of somewhat smaller but damaging earthquakes that occurred in the New Madrid seismic zone in 1843 and 1895.

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Impact of the Hazard

The impacts of earthquakes on Missouri can be significant. The New Madrid earthquakes of 1811–1812 are among the largest that have happened on the North American continent. Although losses were limited because of the sparse population of the time, many Native Americans died and property was damaged to the point that resettlement became a national policy.

The most important direct earthquake hazard is ground shaking. Ground shaking affects structures close to the earthquake epicenter but can also affect those at great distances, particularly where thick clay-rich soils can amplify ground motions. Certain types of buildings are more vulnerable to ground shaking than others. Unreinforced masonry structures, tall structures without adequate lateral resistance, and poorly maintained structures are specifically susceptible to large earthquakes.

According to DNR's Division of Geology and Land Survey, damage from earthquakes in the New Madrid Seismic Zone will vary depending on the earthquake magnitude, the character of the land, and the degree of urbanization. The Bootheel area is dominantly rural with scattered small to medium-sized towns. Damage to the land could be extensive and significantly affect the area's farming industry. The more distant, densely populated urban area of St. Louis is not likely to have damage to the land, but its huge stock of structures and their contents could receive significant damage from shaking and earthquake-triggered landslides and sinkhole collapse. Shaking would be most severe to development built on thick, clay-rich soils. Roads and railroads in southeast Missouri and Saint Louis area could be severely damaged by earthquake triggered slope failures, rockfalls, and liquefaction.

During most earthquakes, liquefaction happens in relatively small isolated patches. The New Madrid Seismic Zone is unique because it is in a vast area with ideal conditions for liquefaction. Liquefaction could be an enormous problem in a large earthquake and even for a magnitude 6–6.5 earthquake occurring in a portion of the Bootheel. Infrastructure (roads, bridges, power lines, gas lines, water lines, petroleum pipelines, telephone lines, ports, etc.) will be severely damaged and disrupted by liquefaction. This will make it difficult to perform rescue and recovery operations because these infrastructure facilities will be needed but will take a long time to repair.

Several studies indicate the need to prepare for earthquakes, as scholars estimate that the New Madrid Seismic Zone has the capability of generating Mercalli intensities of X (ten) in southeast Missouri. The late Dr. Otto Nuttli of St. Louis University stated in his book, *The Effects of Earthquakes in the Central United States*, that surface-wave magnitudes of 7.6 (Richter) would create the largest possible earthquake that could occur anywhere along the New Madrid Seismic Zone in the near future. Information on preparedness and predictions related to the New Madrid Seismic Zone is provided on the U.S. Geological Survey Earthquake Hazards Program web site at www.usgs.gov/hazards, and the Center for Earthquake Research and Information web site at www.ceri.memphis.edu/usgs.

The information in Table 3.14 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.14. EMAP Impact Analysis: Earthquakes

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Health and Safety of Personnel Responding to the Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require relocation of operations and lines of succession execution.
Property, Facilities, and Infrastructure	Damage to facilities and infrastructure in the area of the incident may be extensive for facilities, people, infrastructure, and HazMat.
Delivery of Services	Disruption of lines of communication and destruction of facilities may extensively postpone delivery of services.
The Environment	May cause extensive damage, creating denial or delays in the use of some areas. Remediation needed.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time.
Regulatory and Contractual Obligations	Regulatory waivers may be needed. Fulfillment of contracts may be difficult. Demands may overload ability to deliver.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

The chances of an earthquake increase each day. Energy from the movement of the North American Plate continues to build up along both the New Madrid and Nemaha seismic zones and their subsidiary systems. The state will have an earthquake. We don’t know exactly where or when, but we are overdue for a moderate earthquake. The earthquakes may affect the citizens of Missouri and surrounding states. Earthquakes also have secondary effects such as fires, building collapses, utility disruptions, dam failures, flooding, hazardous material releases, environmental impacts, and economic disruptions or losses.

Separate sections quantify the potential earthquake losses to the state and its jurisdictions. These are Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction and Section 3.4 Assessing Vulnerability and Estimating Potential Losses of State Facilities.

3.2.4. Fires (Structural, Urban, and Wild)

Description of Hazard

Fires can range in scope to include structural fires, urban fires, and wildfires. For the purpose of this analysis, structural and urban fires are considered in one category, with wildfires, including forest, prairie, and grassland locations, considered separately.

Structural and Urban Fire

Structural fires are a major problem that can affect any area of the state. The Missouri Division of Fire Safety (DFS) indicates that approximately 80 percent of the fire departments in Missouri are staffed with volunteers dedicated to the task of fire prevention and suppression. Whether paid or volunteer, these departments are often limited by lack of resources and financial assistance. The impact of a fire to a single-story building in a small community may be as great as that of a larger fire to a multistory building in a large city.

Because fires can occur anywhere in the state, the DFS continues to actively promote the enactment of a statewide fire code. Although no statewide code has been enacted to date, successful legislative efforts to improve fire safety have included the following:

- Fire, Safety, Health, and Sanitation Inspections of Child Care Facilities (*RSMo 210.252*)
- Boiler and Pressure Vessel Safety Act (*RSMo 650.200*)
- Elevator Safety Act (*RSMo 701.350*)
- Fireworks Safety Act (*RSMo 320-111*)
- Amusement Ride Safety Act (*RSMo 316.200-211*)

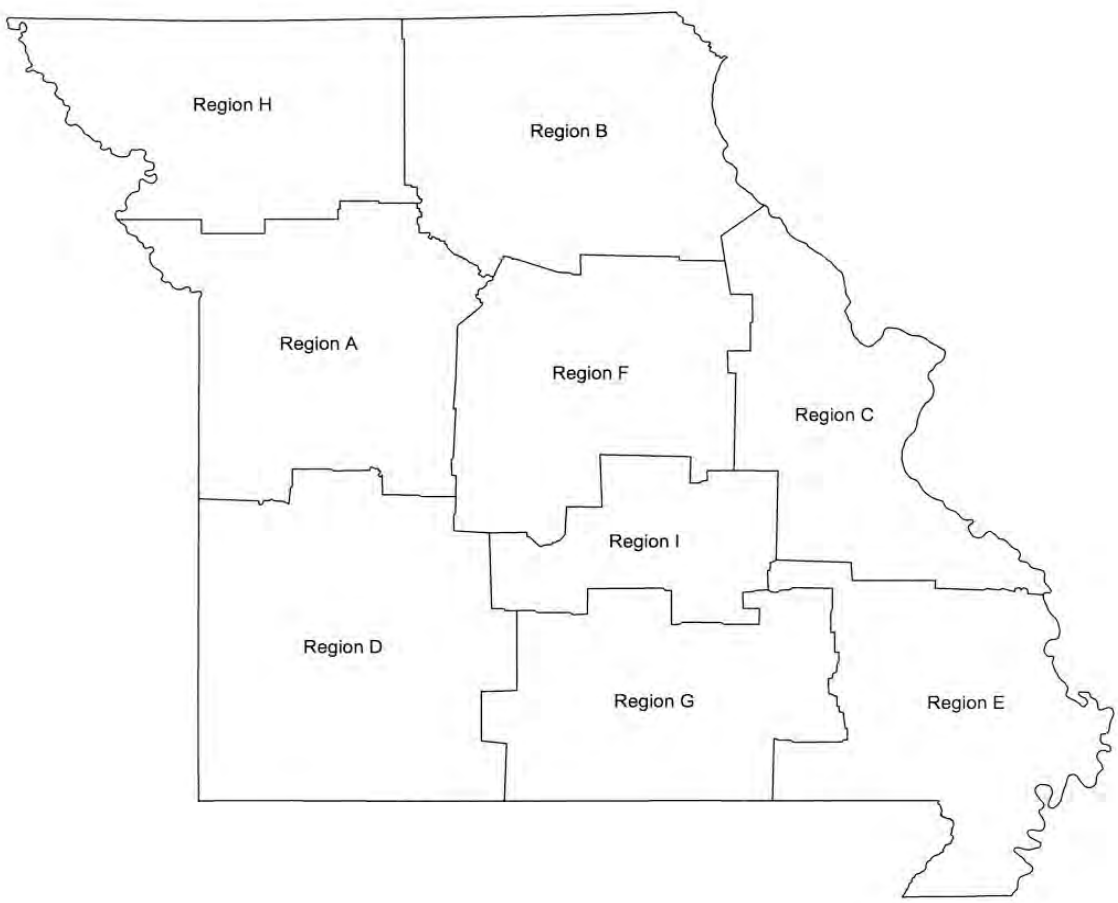
Fires impact many aspects of society in terms of economic, social, and other indirect costs. According to the DFS, the most costly crime in the state is arson. This should be a great concern to citizens, law enforcement, the judicial system, and the fire service sector. Fires caused by arson impact citizens through higher insurance premiums, lost jobs, loss of lives, injuries, and property loss. Primary duties of the state fire marshal include the investigation of fires, explosions, and any related occurrences. The investigative staff is responsible for investigating any fire requested by fire service and law enforcement within the state. This also includes explosions, bombings, and all other related offenses.

Presently, the DFS investigative staff includes 1 deputy chief, 2 regional chiefs and 16 field investigators. This staff must cover all 114 counties and is dedicated to assisting any local or state agency and conducting quality investigations. The investigators are trained in several fields of expertise, including arson for fraud, explosives recognition, and postblast training. The division uses two canines specifically trained in explosives detection. Another tool utilized by the investigation unit is the Computerized Voice Stress Analyzer.

The DFS Training Unit develops and oversees the training curriculum being provided regionally for state certification of firefighters, fire investigators, fire inspectors, and fire service instructors. Although firefighter certification is not mandatory in Missouri, currently over 48,000 individuals are certified by the DFS.

Also, the DFS has initiated a statewide mutual aid system. This system enhances the ability of rural (volunteer) or city (paid) fire departments to handle major fires or incidents within their jurisdictions. To complement the statewide mutual aid system, an incident management system (IMS) overhead team concept has been developed throughout the state. This should assist the rural and city fire departments in the management of a major fires and manmade or natural disasters. Figure 3.21 shows the Fire/Rescue Mutual Aid Regions in Missouri.

Figure 3.21. Missouri Fire and Mutual Aid Regions



The DFS is responsible for the enforcement of fireworks laws throughout Missouri. In addition to conducting inspections of any facilities involved with fireworks, approximately 1,513 permits are issued yearly to manufacturers, wholesalers, and retailers of fireworks. Persons conducting public fireworks shows are required to obtain a fireworks operator license issued by the DFS. Illegal fireworks are a concern, because they can be dangerous, causing loss of lives, severe injuries, and property damage.

Wildfire

The Forestry Division of the Missouri Department of Conservation (MDC) is responsible for protecting privately owned and state-owned forests and grasslands from the destructive effects of wildfires. To accomplish this task, eight forestry regions have been established in the state to assist with the quick suppression of fires (see Figure 3.22). The MDC also has two fire zones, one dispatched from Camdenton and one from Rolla. The Forestry Division works closely with volunteer fire departments and federal partners to assist with fire suppression activities. Currently, 830 rural fire departments have mutual aid agreements with the Forestry Division to obtain assistance in wildfire protection if needed; a cooperative agreement with the Mark Twain National Forest is renewed annually. Figure 3.23 illustrates the Mark Twain National Forests across Missouri.

Figure 3.22. Missouri Department of Conservation Forestry Regions

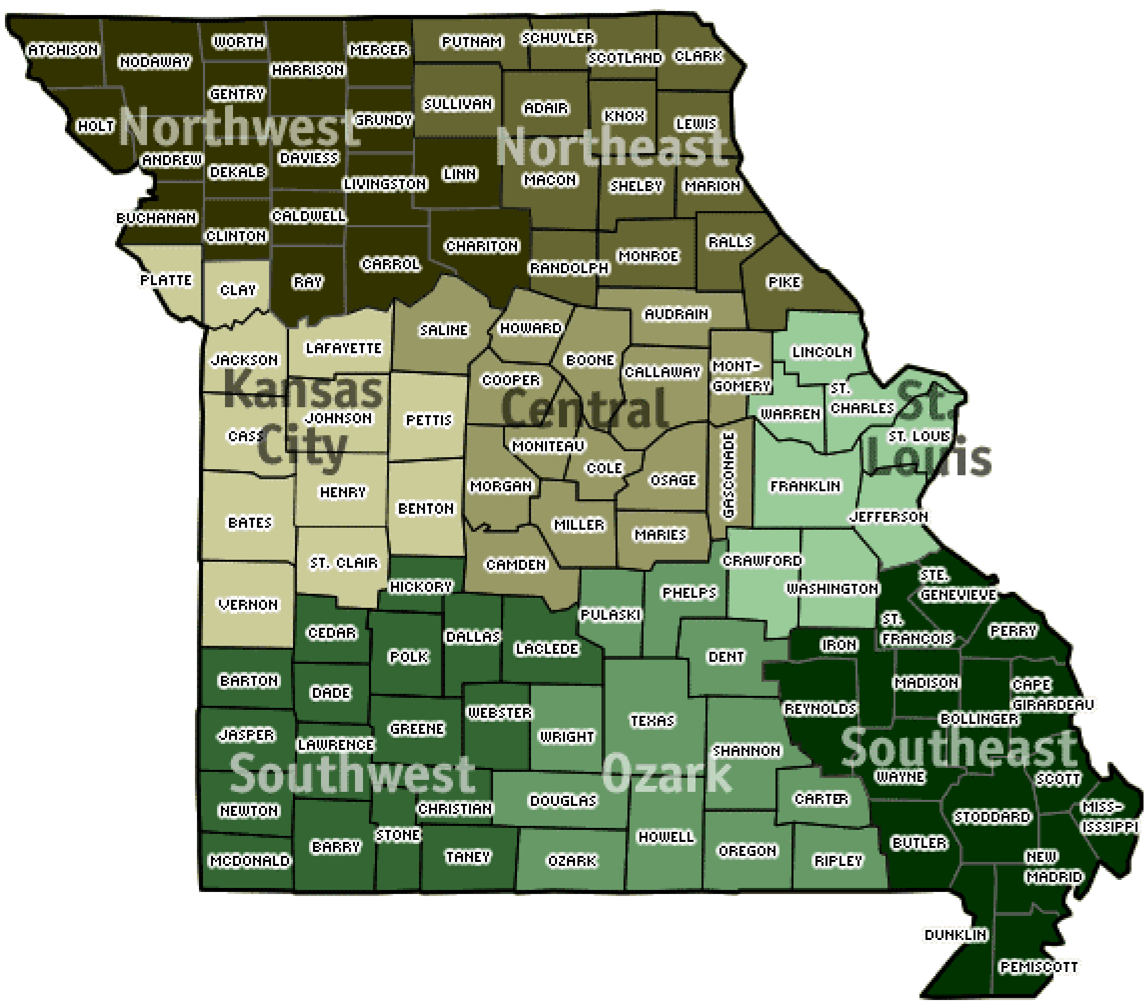
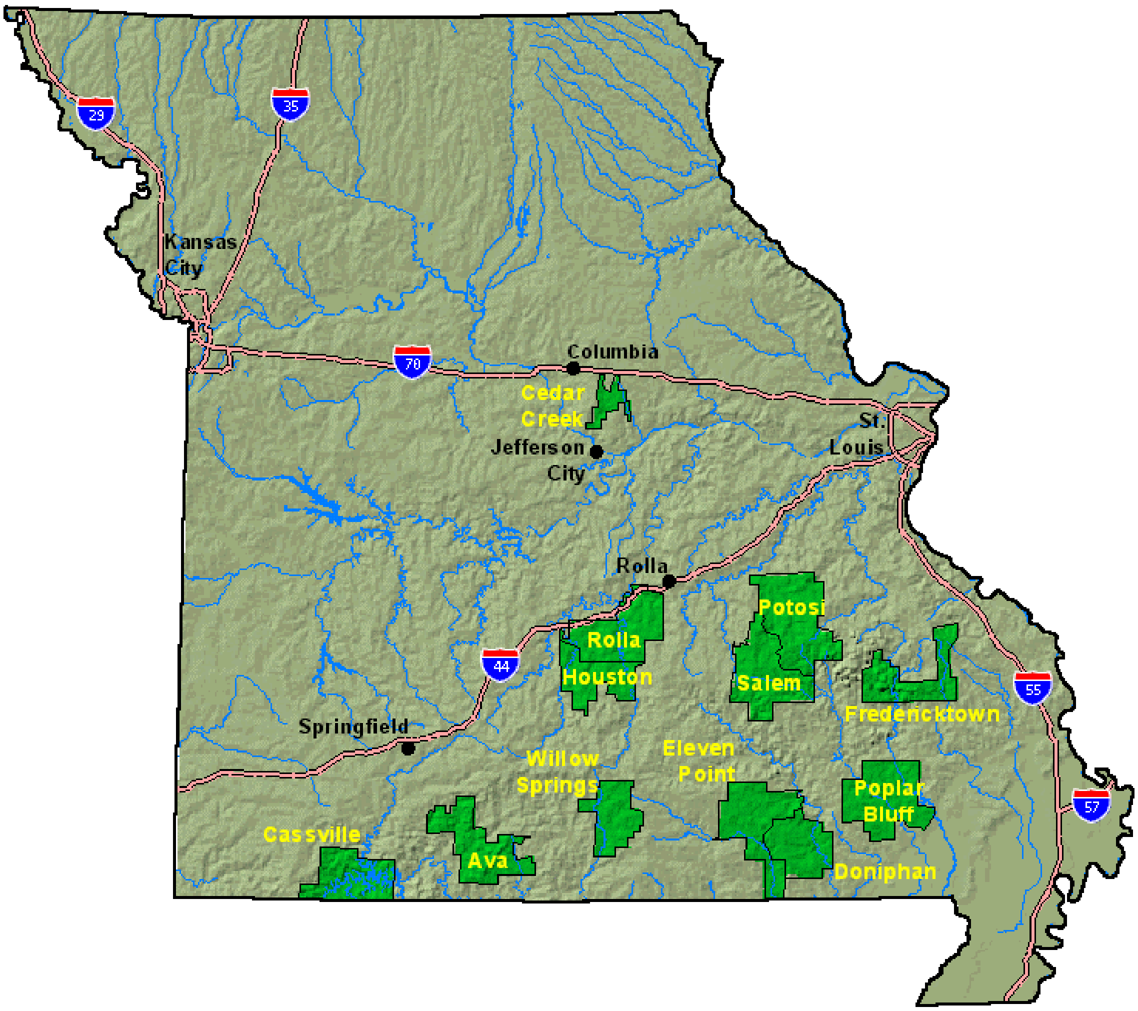


Figure 3.23. Mark Twain National Forests



Forest and grassland fires can occur any day throughout the year. Each year, an average of about 3,700 wildfires burn more than 55,000 acres of forest and grassland in Missouri. Most of the fires occur during the spring season, normally between February 15 and May 10. The length and severity of burning periods largely depend on the weather conditions. Spring in Missouri is noted for its low humidity and high winds. These conditions, together with below-normal precipitation and high temperatures, result in extremely high fire danger. In addition, due to the continued lack of moisture throughout many areas of the state, conditions are likely to increase the risk of wildfires. Drought conditions can also hamper firefighting efforts, as decreasing water supplies may not provide for adequate firefighting suppression. Spring is when many rural residents burn their garden spots, brush piles, and other areas. Some landowners also believe it is necessary to burn their forests in the spring to promote grass growth, kill ticks, and reduce brush. Therefore, with the possibility of extremely high fire dangers and the increased opportunities for fires, the spring months are the most dangerous for wildfires. The second most critical period of the year is

fall. Depending on the weather conditions, a sizeable number of fires may occur between mid-October and late November.

In north and west-central Missouri, the MDC has limited firefighting forces. Forestry Division personnel, however, provide training and limited federal excess equipment to the many volunteer rural fire departments. See Figure 3.22 for a map of the MDC forestry regions.

Historical Statistics

Structural and Urban Fire

Because buildings exist anywhere people live and work, fires can occur at anytime and anyplace throughout the state. The frequency of structural fires depends on a wide range of factors. These factors include, but are not limited to, population or building density, building use, lack of fire codes, lack of enforcement when fire codes exist, fire safety practices (or lack thereof) by building occupants, lack of adequately equipped fire departments, and criminal intent related to arson.

Data on the frequency of structural fires is included in the National Fire Incident Reporting System Statistics (NFIRS) data provided by the DFS (See Table 3.15). However, according to the DFS, almost 731 of approximately 896 fire departments have reported data used to compile the NFIRS. Without 100 percent reporting, definitive conclusions are not possible; however, fire departments, law enforcement offices, and other agencies spend considerable manpower and funding to respond to and investigate structural fires.

Table 3.15. Missouri Structural Fire Statistics

Year	Total Fires	Total Fire Dollar Loss	Fire Related Injuries	Fire Related Deaths
2002	19,749	$ 80,184,764	225	39
2003	22,097	$ 68,193,344	272	48
2004	30,731	$103,699,511	371	86
2005	24,182	$ 99,120,053	319	51

Wildfire

The Forest Division of the MDC is responsible for protecting the privately owned and state-owned forests and grasslands from wildfires. To accomplish this task, eight forestry regions have been established. At the present time, the forestry regions afford intensive fire protection to approximately one-half of the state, or about 16 million acres. Within these regions, fairly accurate forest and grassland fire statistics are available from the MDC. In a typical year, approximately 3,700 wildfires occur.

In 2006, 3,553 wildfires occurred in Missouri, burning 52,419 acres. Debris burning (fires resulting from land clearing, burning trash, range, stubble, right-of-way, logging slash, etc.) is the major cause of forest and grass fires in Missouri. Incendiary fires (fires willfully set by

anyone on property not owned or controlled by him and without the consent of the owner) continue to rank second in the number of wildfires that occur each year.

Table 3.16 lists the number and causes of forest and grassland fires in 2006 and the acres burned. Table 3.17 shows the number of fires and acreage burned by forest and grassland fires yearly from 1993 to 2006.

Table 3.16. 2006 Statewide Forest and Grassland Fires by Cause

Cause	Number	Acres	% Number	% Acres
Lightning	37	695.26	1.0%	1.3%
Campfire	29	477.13	0.8%	0.9%
Smoking	67	790.35	1.9%	1.5%
Debris	1,524	17,372.96	42.9%	33.1%
Arson	338	13,988.13	9.5%	26.7%
Equipment	135	591.50	3.8%	1.1%
Railroad	7	206	0.2%	0.4%
Children	23	153.26	0.6%	0.3%
Miscellaneous	1,393	18,144.45	39.2%	34.6%
Totals	3,553	52,419.04	100.0%	100.0%

Table 3.17. Statewide Forest and Grassland Fires and Acres Burned, 1993–2006

Year	Fires	Acres
1993	2,994	31,952
1994	2,748	51,896
1995	2,910	48,907
1996	3,793	88,933
1997	2,487	29,557
1998	1,112	10,415
1999	1,348	18,270
2000	4,910	132,718
2001	2,972	41,092
2002	2,376	54,397
2003	2,378	47,692
2004	2,917	55,732
2005	1,610	38,921
2006	3,553	52,419

Despite the fact that Missouri experiences an average of 3,700 wildfires each year, Missouri has only received one fire management assistance declaration. This was for the Camden Fire Complex in 2000. At the time of the declaration, the complex consisted of 70 fires burning on

3,000 acres of grassland that had destroyed 17 homes and forced the evacuation of approximately 300 residents in Camden County communities from Macks Creek to Climax Springs. Additional information about this fire and other historical fires in Missouri was not available at the time this plan was written. While wildfires can happen in Missouri, historical data on losses and impacts is not readily available to support further vulnerability and loss estimation.

Measure of Probability and Severity

Structural and Urban Fire

Probability: High
Severity: Moderate

Even with the limited data in the NFIRS statistics, the probability of structural fires is quite high. Total monetary loss in 2005, according to the NFIRS, was over $103 million. In addition, there were 51 fire-related deaths in Missouri during 2005. Therefore, severity could be considered moderate.

Wildfire

Probability: Moderate
Severity: Low to Moderate

The probability of wildfires (forest, prairie, and grassland) is considered moderate overall, but may increase to high during certain periods, such as spring or late fall, or under conditions of excessive heat, dryness, or drought. The severity would be considered low to moderate.

Impact of Hazard

Structural and urban fires are a daily occurrence throughout the state. Approximately 100 fatalities occur annually, as well as numerous injuries affecting the lives of the victims, their families, and many others—especially those involved in fire and medical services. Unlike other disasters, structural fires are often insidious and despicable due to the prevalence of arson. All citizens pay the costs of arson whether through increased insurance rates, higher costs to maintain fire and medical services, or the costs of supporting the criminal justice system.

The information in Table 3.18 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.18. EMAP Impact Analysis: Fires

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be severe for incident areas and moderate to light for other adversely affected areas.
Health and Safety of Personnel Responding to the Incident	Localized impact expected to limit damage to personnel in the incident areas at the time of the incident.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the area of the incident. Some severe damage possible.
Delivery of Services	Localized disruption of roads and/or utilities caused by incident may postpone delivery of some services.
The Environment	Localized impact expected to be severe for incident areas and moderate to light for other areas affected by smoke or HazMat remediation.
Economic and Financial Condition	Local economy and finances may be adversely affected, depending on damage and length of investigations.
Regulatory and Contractual Obligations	Regulatory waivers may be needed locally. Fulfillment of some contracts may be difficult. Impact may temporarily reduce deliveries.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

With sufficient mutual aid, local fire services have adequate day-to-day fire service capabilities. The greatest risk of interaction by fires with other hazards may involve damaging earthquakes. In these circumstances, the possibility of numerous fires and reduced firefighting capabilities would greatly increase the severity of structural fires.

3.2.5. Heat Wave

Description of Hazard

A heat wave is a period of excessive heat, which can lead to illness and other stress to people with prolonged exposure to these conditions. High humidity, which often accompanies heat in Missouri, can make the effects of heat even more harmful. While heat-related illness and death can occur from exposure to intense heat in just one afternoon, heat stress on the body has a cumulative effect. Consequently, the persistence of a heat wave increases the threat to public health. The National Weather Service (NWS) defines a heat wave as three consecutive days of temperatures of 90 degrees Fahrenheit (°F) and above. These high temperatures generally occur from June through September, but are most prevalent in the months of July and August. Missouri experiences about 40 days per year above 90°F, based on a 30-year average compiled by the NWS from 1961 through 1990. July leads this statewide mean with 15 days above 90°F, followed by August with an average of 12 days over 90°F. June and September average 6 days and 4 days, respectively, for temperatures above 90°F. The 30-year climatic data is from NWS stations at Kansas City, Columbia, Springfield, and St. Louis. As these regional locations indicate, all of Missouri is subject to heat wave during the summer months.

July 2006 was no exception to heat wave conditions in Missouri. The National Weather Service indicated that the July temperatures following the St. Louis storm were expected to be 91-95°F within a one-week period with the heat indices expected to reach 100°F in the metro area at that time. A federal disaster declaration was received on July 21, 2006, for the City of St. Louis and surrounding counties to the west and southwest of the city. Heat wave conditions continued throughout the month of July with heat indices reaching 105–115°F by the end of the month. The storm event caused many households and businesses to be without power for an extended period of time. The power outages caused the heat wave to have a profound effect on individuals residing within the impacted area. By July 31, 2006, 10 heat-related deaths had been reported in Jefferson County, St. Louis City, and St. Louis County.

Along with humans, animals also can be affected by high temperatures and humidity. For instance, cattle and other farm animals respond to heat by reducing feed intake, increasing their respiration rate, and increasing their body temperature. These responses assist the animal in cooling itself, but this is usually not sufficient. The hotter the animal is, the more it will begin to shut down body processes not vital to its survival, such as milk production, reproduction, or muscle (meat) building.

Ambient temperature is not the only factor that should be considered when assessing the likely effects of heat. Relative humidity must also be considered along with duration of exposure, wind, and activity. The NWS has stepped up its efforts to more effectively alert the general public and appropriate authorities to the hazards of heat waves—those prolonged episodes of excessive heat and humidity. The NWS has devised a Heat Index (HI), which is a combination of air temperature and relative humidity that more accurately reflects the heat intensity.

The HI, given in degrees Fahrenheit, is an accurate measure of how hot it really feels when the relative humidity (RH) is added to the actual air temperature. The Heat Index Chart is shown in Figure 3.24. As an example, if the air temperature is 96°F (found on the left side of the table), and the relative humidity is 55 percent (found at the top of the table), the HI is 112°F (the intersection of the 96°F row and the 55 percent column). Because HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Figure 3.24. Heat Index Chart

Temperature (F) versus Relative Humidity (%)

°F	90%	80%	70%	60%	50%	40%	30%	20%	10%
65	65.6	64.7	63.8	62.8	61.9	60.9	60.	59.1	58.1
70	71.6	70.7	69.8	68.8	67.9	66.9	66.	65.1	64.1
75	79.7	76.7	75.8	74.8	73.9	72.9	72.	71.1	70.1
80	88.2	85.9	84.2	82.8	81.6	80.4	79.	77.4	76.1
85	101.4	97.	93.3	90.3	87.7	85.5	83.5	81.6	79.6
90	119.3	112	105.8	100.5	96.1	92.3	89.2	86.5	84.2
95	141.8	131.1	121.7	113.6	106.7	100.9	96.1	92.2	89.2
100	168.7	154.	140.9	129.5	119.6	111.2	104.2	98.7	94.4
105	200	180.7	163.4	148.1	134.7	123.2	113.6	105.8	100.
110	235.	211.2	189.1	169.4	151.9	136.8	124.1	113.7	105.8
115	275.3	245.4	218	193.3	171.3	152.1	135.8	122.3	111.9
120	319.1	283.1	250.	219.9	192.9	169.1	148.7	131.6	118.2

Risk Level	Possible Heat Disorder:
Caution	Fatigue possible with prolonged exposure and physical activity.
Extreme Caution	Sunstroke, heat cramps and heat exhaustion possible.
Danger	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
Extreme Danger	Heat stroke highly likely with continued exposure.

*Note: On the HI chart, the shaded zone above 105°F corresponds to a level that may cause increasingly severe heat disorders with continued exposure or physical activity.

Heat waves are often a major contributing factor to power outages (brownouts, etc.), as the high temperatures result in a tremendous demand for electricity for cooling purposes. Power outages for prolonged periods increase the risk of heat stroke and subsequent fatalities due to loss of cooling and proper ventilation.

Other related hazards include water shortages brought on by drought-like conditions and high demand. Local advisories, which list priorities for water use and rationing, are common during heat waves. Government authorities report that civil disturbances and riots are also more likely to occur during heat waves, as well as incidents of domestic violence and abuse. In cities, pollution

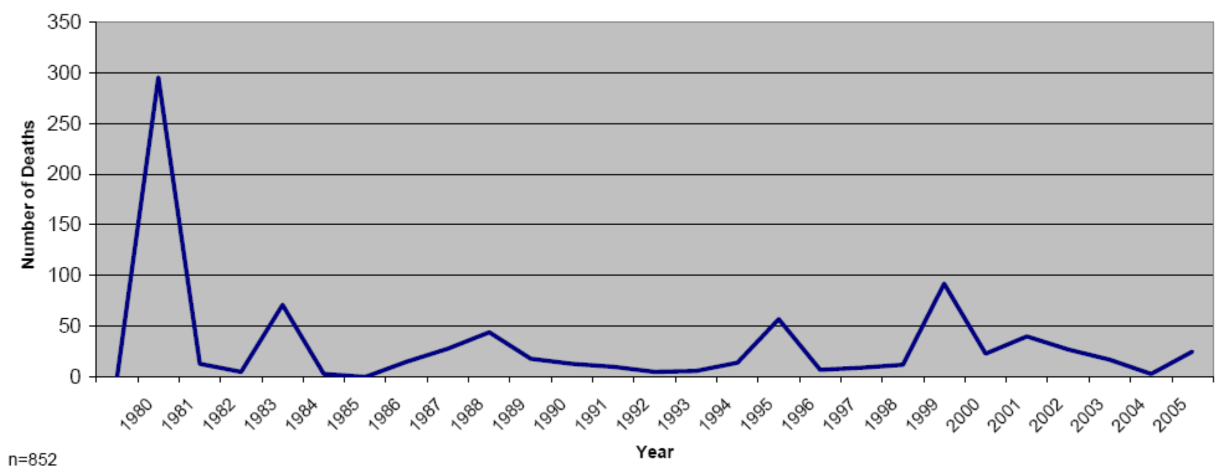
becomes a problem because the heat traps pollutants in densely developed urban areas. Adding pollution to the stresses of the heat magnifies the health threat to the urban population.

Historical Statistics

Heat kills by taxing the human body beyond its abilities. According to the National Oceanic and Atmospheric Administration Office of Climate, Water, and Weather, approximately 175 Americans succumb to summer heat in an average year. In the 40-year period 1936 through 1975, nearly 20,000 people died in the United States from the effects of heat and solar radiation. Some of the worst years for heat-related deaths occurred during the Great Depression, with 843 deaths in 1934, and 644 in 1936. The worst year in the past few decades was 1980, with 1,250 deaths from excessive heat.

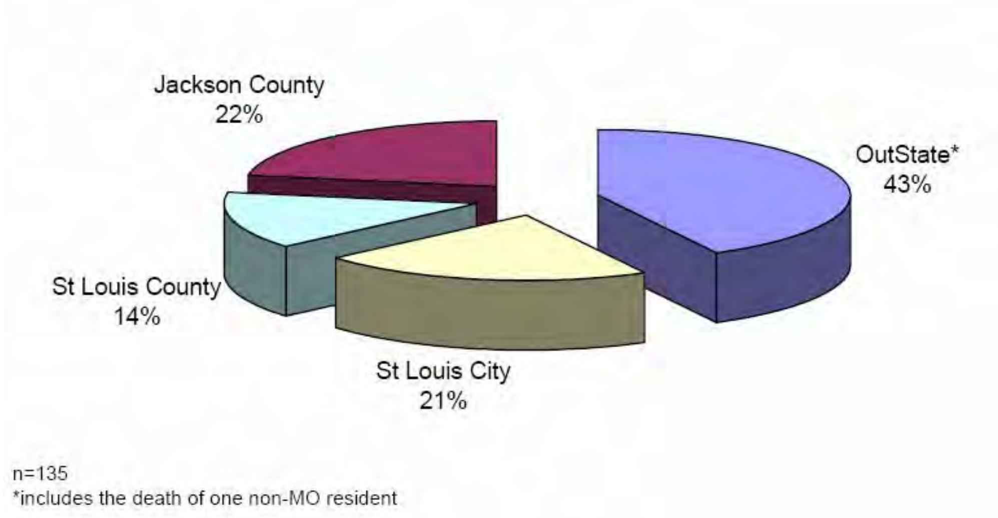
The former Missouri Division of Health (now the Department of Health and Senior Services) initiated statewide hyperthermia death surveillance in 1980 in response to a summer heat wave that resulted in the death of 295 individuals (see Figure 3.25). The program defines hyperthermia as physician-diagnosed heat exhaustion, heat stroke, or hot weather/natural environment as a contributing factor in a death. In 2005, 25 Missourians died from heat-related illnesses. Missouri's heat-related deaths are primarily in the urban, more densely populated areas of St. Louis City, St. Louis County, and Jackson County (Kansas City). Of the 135 deaths between 2000 and 2005, 78 (57.8 percent) were in these metropolitan areas (see Figure 3.26). The greatest number (294, 63 percent) of deaths 1984–2005 have been of people age 65 years and older.

Figure 3.25. Hyperthermia Deaths, Missouri, 1980-2005



Source: Missouri Department of Health and Senior Services

Figure 3.26. Hyperthermia Deaths by Geographic Area, Missouri, 2000-2005



Source: Missouri Department of Health and Senior Services

Measure of Probability and Severity

Probability: Moderate
Severity: Moderate

Based on 30-year statistics from the NWS indicating the state's mean number of days above 90°F, Missouri is vulnerable to heat waves ranging from high to moderate risk in July and August. The NWS has developed a Heat Index/Heat Disorder Chart that relates ranges of HI with specific disorders, particularly for people in higher risk groups (see Table 3.19).

Table 3.19. Heat Index/Heat Disorder Chart

Heat Index	Heat Disorder
130°F or higher	Heat stroke or sunstroke likely with continued exposure.
105 to 129°F	Sunstroke, heat cramps, or heat exhaustion likely, and heat stroke possible with prolonged exposure or physical activity.
90 to 104° F	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure or physical activity.
80 to 89°F	Fatigue possible with prolonged exposure or physical activity.

Table 3.20 shows the three response levels developed by the NWS, based on the Heat Index, to alert the public to the potential heat hazards:

Table 3.20. Heat Index Response Levels

Heat Index	Response Level
130°F or higher	Warning
105 to 129°F	Watch
90 to 104°F	Advisory

Based on information from the Department of Health and Senior Services and the NWS, the state rates the probability of a heat wave as moderate and severity as moderate, but the probability could be upgraded to severe.

The Missouri Department of Health and Senior Services will announce a statewide hot weather health alert (Table 3.21) when the conditions are as follows:

Table 3.21. Missouri Department of Health and Senior Services Hot Weather Alerts

Type of Alert	Conditions of Alert
Hot Weather Health Alert	Heat indices of 105°F in a large portion of the state are first reached (or predicted).
Hot Weather Health Warning	Heat indices have been 105°F or more for two days in a large portion of the state, or weather forecasts call for continued heat stress conditions for at least 24 to 48 hours over a large portion of the state.
Hot Weather Health Emergency	When extensive areas of the state meet the following criteria: (1) high sustained level of heat stress (HI 105°F for 3 days), (2) increased numbers of heat-related illnesses and deaths statewide, and (3) the NWS predicts hot, humid temperatures for the next several days for a large portion of the state.

Impact of the Hazard

The severity of heat disorders tends to increase with age. Heat cramps in a 17-year-old can become heat exhaustion for someone in their forties and may result in a fatal stroke for someone in their sixties. Table 3.22 lists conditions associated with heat, their symptoms, and suggested first aid.

Table 3.22. Heat Disorders/Symptoms/First Aid

Heat Disorder	Symptoms	First Aid
Sunburn	Redness and pain. In severe cases, swelling of skin, blisters, fever, and headaches.	Apply ointment for mild cases if blisters appear. If breaking occurs, apply dry sterile dressing. Serious, extensive cases should be seen by physician.
Heat Cramps	Painful spasms possible usually in muscles of legs and abdomen. Heavy sweating.	Apply firm pressure on cramping muscles, or gentle massage to relive spasms. Give sips of water.
Heat Exhaustion	Heavy sweating and weakness; cold, pale and clammy skin. Pulse thready. Normal temperature possible. Fainting and vomiting.	Get victim out of sun. Lie down and loosen clothing. Apply cool wet cloths. Fan or move victim to air conditioned room. Give sips of water. If vomiting continues, seek immediate medical attention.
Heat Stroke (or Sunstroke)	High body temperature (106°F, or higher). Hot dry skin. Rapid and strong pulse. Possible unconsciousness.	Heat stroke is a severe medical emergency. Summon medical assistance or get the victim to a hospital immediately. Delay can be fatal. Move the victim to cooler environment. Reduce body temperature with cold bath or sponging. Use extreme caution. Remove clothing. Use fans and air conditioners. If temperature rises again, repeat process. Do not give fluids.

The following population groups are at a greater risk to becoming very sick from heat waves:

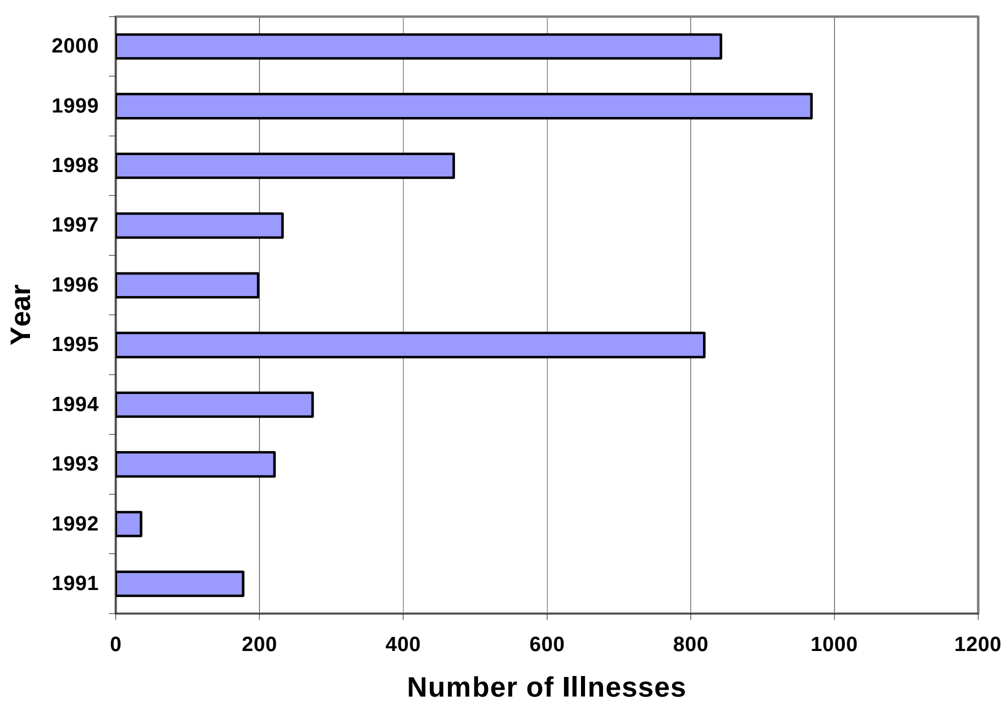
- Those vulnerable to heat stress due to physical condition
  - Older people
  - Children
  - People overweight or underweight
- People with limited independence due to physical or mental disorders

- People in institutional settings without air conditioning
- People working in heat under stress (firefighters, police, emergency medical technicians)
- People in urban environments where heat retention in asphalt, concrete, and masonry is a factor (heat island effect)
- People with low income who lack resources for air conditioning, transportation, medical care, etc.

- Those with increased risk from work or leisure activities
  - People who work outdoors (utility crews, construction crews, etc.)
  - Military personnel and trainees
  - Athletes
- Those more difficult to reach through normal communications
  - People who live alone
  - People who are homeless
  - People who do not speak English
  - People who cannot read
  - People who are culturally, socially, or geographically isolated

Even when a heat injury isn't fatal, it can be extremely serious and require lifelong monitoring of further exposure to heat. Besides mortality statistics due to heat, the Missouri Department of Health and Senior Services tracks heat-related injuries. Figure 3.27 shows heat-related illnesses in Missouri from 1991 through 2000.

Figure 3.27. Number of Heat-Related Illnesses in Missouri, 1991–2000



As previously mentioned, animals can be adversely affected by heat stress. This poses a risk to farmers, ranchers, and the entire state, which relies on agricultural revenue to keep the economy strong. Livestock producers cannot afford to ignore the effects of high temperatures on their herds. The following symptoms are signs of heat stress on livestock:

- Restlessness and crowding under shade or at water tanks/areas
- Open-mouthed breathing or panting and increased salivating
- Increased respiration rates
- Gasping and lethargic demeanor

The information in Table 3.23 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.23. EMAP Impact Analysis: Heat Wave

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Health and Safety of Personnel Responding to the Incident	Nature of hazard expected to minimize any serious damage to properly equipped and trained personnel.
Continuity of Operations	Unlikely to necessitate execution of the Continuity of Operations Plan.
Property, Facilities, and Infrastructure	Nature of hazard expected to minimize any serious damage to facilities.
Delivery of Services	Extent of agricultural damage depends on duration. Water supplies and electricity may be disrupted.
The Environment	May cause disruptions in wildlife habitat, increase interface with people, and reduce numbers of animals.
Economic and Financial Condition	Local economy and finances dependent on stable electricity and water supply adversely affected for duration of heat wave.
Regulatory and Contractual Obligations	Regulatory waivers likely unnecessary. Fulfillment of some contracts and deliveries may be difficult if electricity and water disrupted.
Reputation of or Confidence in the Entity	Ability to manage situation may be questioned and challenged if planning and response not timely and effective.

Synopsis

Many people do not realize how deadly a heat wave can be. In contrast to the visible, destructive, and violent nature of floods, hurricanes, and tornadoes, a heat wave is a “silent killer.” Be aware

of the warning signs of heat-related illness, such as light-headedness, mild nausea or confusion, sleepiness, or profuse sweating. To prevent heat-related illness, take the following precautions:

- Increase your fluid intake; drink more liquids than your thirst indicates.
- Drink nonalcoholic and caffeine-free liquids, such as water and juices.
- Wear lightweight, light-colored, loose-fitting clothing.
- When unaccustomed to working or exercising in a hot environment, start slowly and pick up the pace gradually; rest frequently in a shady area.
- Spend time in an air-conditioned place; if not at home, then spend time in such public places as libraries, supermarkets, shopping malls, and movie theatres.
- Do not rely on fans as your primary cooling devices during a heat wave.
- Schedule outdoor activities carefully, preferably before noon or in the evening.
- When working in the heat, monitor the condition of your coworkers and have someone do the same for you.
- Monitor those at high risk, such as the elderly, infants, and children up to four years of age, someone who is overweight, or someone on medication.
- Ask your physician whether you are at particular risk because of medication.
- Do not leave infants, children, or pets unattended in a parked car or other hot environments.

Although fans are less inexpensive to operate, they may not be effective, and may even be harmful when temperatures are very high. As the air temperature rises, airflow is increasingly ineffective in cooling the body until ly, at temperatures above 100°F (the exact number varies with the humidity); increasing air movement actually increases heat stress. More specifically, when the temperature of the air rises to about 100°F, the fan may be delivering overheated air to the skin at a rate that exceeds the capacity of the body to get rid of this heat, even with sweating, and the net effect is to add heat rather than to cool the body. An air conditioner, if one is available, is a much better alternative. More information on heat-related illness is available through the Department of Health and Senior Services' web page at www.health.state.mo.us/ColdAndHeat/CandH.html.

3.2.6 Land Subsidence/Sinkholes

Description of Hazard

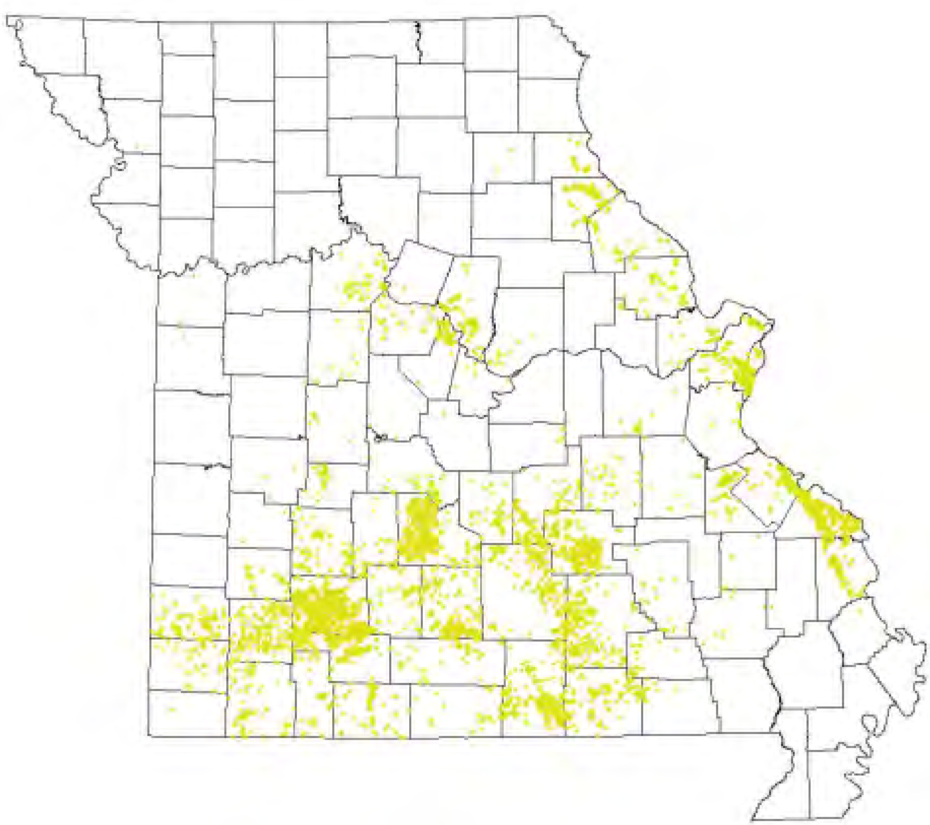
Land subsidence is sinking of the earth's surface due to the movement of earth materials below the surface. This sinking can be sudden or gradual and is generally attributed to the removal of subsurface water or the draining of organic soils. In Missouri, subsidence is primarily associated with sinkholes. In the case of sinkholes, the rock below the surface is limestone, carbonate rock, salt beds, or some other rock that can be naturally dissolved by circulating groundwater. As the rock dissolves, spaces and caverns form, and ultimately the land above the spaces collapses. In Missouri, sinkhole problems are usually a result of surface materials above openings into bedrock caves eroding and collapsing into the cave opening. These collapses are called "cover collapses" and geologic information can be applied to predict the general regions where collapse

will occur. Sinkholes range in size from several square yards to hundreds of acres and may be quite shallow or hundreds of feet deep.

Sinkhole formation is most intense where the bedrock is most soluble and has been exposed to extended periods of weathering and where surficial materials are between 40 and 80 feet in thickness and are composed of relict bedrock structure residuum containing clays with low dry densities. Bedrock faulting also contributes to deep weathering, cave formation, and sinkhole formation.

According to the U.S. Geological Survey, the most damage from sinkholes tends to occur in Florida, Texas, Alabama, Missouri, Kentucky, Tennessee, and Pennsylvania. Fifty-nine percent of Missouri is underlain by thick, carbonate rock that makes Missouri vulnerable to sinkholes. Sinkholes occur in Missouri on a fairly frequent basis. Most of Missouri's sinkholes occur naturally in the state's karst regions (areas with soluble bedrock). They are a common geologic hazard in southern Missouri, but also occur in the central and northeastern parts of the state (see Figure 3.28). While most of them are from natural causes, others are a result of human activities. Triggering factors include activities that alter the natural hydrologic conditions, the collapse of storm sewers or other abandoned and forgotten manmade voids, and subsurface mining.

Figure 3.28. Sinkholes in Missouri



Source: Missouri Department of Natural Resources

The 2007 version of the Missouri Environmental Geology Atlas (MEGA 2007) sinkhole location map (Figure 3.28) shows the location of 14,195 sinkholes for the entire state. The sinkhole inventory includes 2,500 in Greene County reports and more than 7,000 in Perry County. This GIS data layer was produced from U.S. Geological Survey topographic information generated at a scale of 1:24,000 with varying topographic contour intervals. It likely underreports the actual number of sinkholes that intersect the surface by a factor of 2 to 10 depending on the degree of solutional weathering at a given locality. There are no statistics on the number of voids present in the subsurface that will collapse in the future to form new surface sinkholes.

Historical Statistics

Sinkholes are a regular occurrence in Missouri, but rarely are the events of any significance. However, there have been occasional damages related to sinkholes. The following events are from Jim Vandike's "That Sinking Feeling—A Void, a Collapse" in the Spring/Summer 2003 issue of Missouri's Department of Natural Resources' Missouri Resources:

In 1948, a well-drilling rig was constructing a mineral-test hole on the St. Francis River floodplain in St. Francois County when sinkholes began developing around the rig. By the time the well was cased, there were approximately 20 sinkholes up to 90 feet long and 20 feet wide within 500 feet of the rig.

A lake in northern Howell County was built in the 1960s on a tributary of the Eleven Point River in an area characterized by deeply weathered bedrock, losing streams, and sinkholes. A sinkhole formed in the floor of the lake and quickly drained it. Efforts to stop the leak failed and the lake will only hold water for short periods following heavy rainfall.

Sinkhole collapses have occurred in sewage lagoons at several southern Missouri towns including West Plains and Republic. In most instances, the lagoons were abandoned and new lagoons were constructed on better sites or the towns switched wastewater-treatment methods.

Mining-related collapses have occurred in the Joplin area where lead and zinc were once mined; southeastern Missouri (Washington, Iron, St. Francois, and Reynolds counties), where lead has been mined since the 1700s; northern and western Missouri (and part of St. Louis) where coal was mined underground prior to the 1940s; and throughout Missouri where underground limestone quarries are common.

Other notable events include the following:

- In August 2006, a sinkhole collapse in the City of Nixa in Christian County severely destroyed a residence and vehicle and threatened adjacent homes and city utilities.
- In February 2005, a sinkhole appeared in a pasture in Barry County and grew to be the size of a football field.
- In June 2004, a sinkhole drained 23-acre Lake Chesterfield in St. Louis County.

Measure of Probability and Severity

Probability: High
Severity: Low

Since sinkholes are common to Missouri, the probability is high that they will occur in the future. They tend to occur in areas away from development and typically do not cause serious damage. Thus, the severity of future events is likely to be low. Nevertheless, this could change with the increasing growth that is taking place in counties in susceptible regions of Missouri.

Impact of the Hazard

Sinkholes vary in size and location. These factors will determine the impact of the hazard, which could manifest as the loss of a personal vehicle, a building collapse, or damage to infrastructure such as roads, water, or sewer lines. Groundwater contamination is also a possible impact of a sinkhole. Because of the relationship of sinkholes to groundwater, pollutants captured in sinkholes (or dumped) can affect a community's groundwater system. Sinkhole collapse could be triggered by large earthquakes, which could be particularly problematic for the St. Louis metropolitan area. Sinkholes located in floodplains can absorb floodwaters but make detailed flood hazard studies difficult to model.

The information in Table 3.24 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.24. EMAP Impact Analysis: Land Subsidence/Sinkholes

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be moderate to severe for incident areas.
Health and Safety of Personnel Responding to the Incident	Limit impacts to personnel responding to the incident.
Continuity of Operations	Limited, unless facility is impacted.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the area of the incident. Some severe damage possible.
Delivery of Services	Localized disruption of roads and/or utilities may postpone delivery of some services.
The Environment	Localized impact expected to be moderate for incident area.
Economic and Financial Condition	Limited. Local economy and finances may be adversely affected, depending on damage.
Regulatory and Contractual Obligations	Regulatory waivers may be needed locally. Impact may temporarily reduce deliveries.
Reputation of or Confidence in the Entity	Localized impact expected to primarily adversely affect property owner(s) confidence in local entities development policies.

Synopsis

Most of Missouri's sinkholes are naturally occurring. Since it is possible to determine the geographical extent of this hazard in most cases, mitigation can be targeted. Avoiding the hazard is much more cost effective than altering or mitigating the sinkhole itself. Some counties, such as Greene and Christian, limit construction in areas near sinkholes.

3.2.7 Riverine Flooding (Major and Flash)

Description of Hazard

Floods are the number one weather-related killer in the United States. Between 1990 and 2004, Missouri recorded more than 82 deaths attributed to flooding. A flood is partial or complete inundation of normally dry land areas. Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt, or ice. There are several types of riverine floods, including headwater, backwater, interior drainage, and flash flooding.

Flash flooding is characterized by rapid accumulation or runoff of surface waters from any source. This type of flooding impacts smaller rivers, creeks, and streams and can occur as a result of dams being breached or overtopped. Because flash floods can develop in a matter of hours, most flood-related deaths result from this type of event.

The areas adjacent to rivers and streambanks that carry excess floodwater during rapid runoff are called floodplains. A floodplain is defined as the lowland and relatively flat area adjoining a river or stream. The terms "base flood" and "100-year flood" refer to the area in the floodplain that is subject to a one percent or greater chance of flooding in any given year, based on historical records. Floodplains are a vital part of a larger entity called a basin, which is defined as all the land drained by a river and its branches.

The land that forms Missouri is contained within the Mississippi, Missouri, Arkansas, and White River basins. The Mississippi River Basin drains the eastern part of the state, the Missouri River Basin drains most of the northern and central part of the state, the White River Basin drains the south-central part of the state, and the Arkansas River Basin drains the southwest part of the state. The Missouri River Basin drains over half the state. When the Missouri River joins the Mississippi River at St. Louis, it becomes part of the Mississippi River Basin, which is the largest basin, in terms of volume of water drained, on the North American continent. River basin and floodplain maps are on file at SEMA.

In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations—areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow. Flooding also occurs due to

combined storm and sanitary sewers that cannot handle the tremendous flow of water that often accompanies storm events. Typically, the result is water backing up into basements, which damages mechanical systems and can create serious public health and safety concerns.

Associated with the riverine flooding hazard are floods caused by breaching or failure of levees. Flooding problems associated with levee failures are discussed in the historical statistics section that follows. In February of 2007, the U.S. Army Corp of Engineers produced a list of 122 levees nationwide that posed an unacceptable risk of failing in a flood. Fortunately, none of these levees are located in Missouri. Based on a 2007 database of levees known by the Corps, there are 66 levees in Missouri. Twenty nine of these are considered to provide 100-year flood protetction. FEMA, as part of its floodplain map modernization effort, has identified 41 levees in Missouiri as provisionally acreddited levees (PAL). These levees need to have evidence presented within the next two years that they provide 100-year flood protection in order to be certified and shown on flood insurance rate maps (FIRM). SEMA has the Corps and FEMA spreadsheets for reference. The mapped location of these levees was noted as a data limitation during the 2007 update to this plan. A preliminary effort to map levees, based on those detected on digital elevation models by HAZUS-MH flood modeling, was started to meet this data deficiency. It is expected that additional data on levees will become available in upcoming years with FEMA's efforts to certify levees nationwide for flood protection.

Historical Statistics

Missouri has a long and active history of extensive flooding over the past century (see Table 3.25). Scores of river communities, such as those along the Mississippi and Missouri rivers, have become quite skilled and experienced in flood-fighting efforts due to frequent instances of severe flooding in recent years. Flooding along Missouri's major rivers generally results in slow moving disasters. River crest levels are forecast several days in advance, allowing communities downstream sufficient time to take protective measures, such as sandbagging and evacuations. Nevertheless, these flood disasters exact a heavy toll in terms of human suffering and extensive losses to public and private property. By contrast, flash flood events in recent years have caused a higher number of deaths and major property damage in many areas of Missouri.

Table 3.25. Presidential Declarations for Missouri Floods Since 1975

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
July 21, 1976	DR 516	Severe Storms, Flooding	n/a	
May 7, 1977	DR 535	Tornadoes, Flooding	Carroll, Clay, Lafayette, Ray, Cass, Jackson, Pettis	PA & IA
September 14, 1977	DR 538	Severe Storms, Flooding	n/a	
March 12, 1979	EM 3071	Ice Jam, Flooding	n/a	

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
April 21, 1979	DR 579	Tornadoes, Torrential Rain, Flooding	n/a	
August 26, 1982	DR 667	Severe Storms, Flooding	n/a	
December 10, 1982	DR 672	Severe Storms, Flooding	n/a	
June 21, 1984	DR 713	Severe Storms, Flooding	n/a	
October 14, 1986	DR 779	Severe Storms, Flooding	n/a	
May 24, 1990	DR 867	Flooding, Severe Storm	n/a	
May 11, 1993	DR 989	Severe Storm, Flooding	Jefferson, Lincoln, Marion, Pike, Ralls, St. Charles, St. Louis, Ste. Genevieve	IA
July 9, 1993	DR 995	Flooding, Severe Storm	Adair, Andrew, Atchison, Audrain, Barry, Barton, Bates, Benton, Boone, Buchanan, Caldwell, Callaway, Camden, Cape Girardeau, Carroll, Cass, Chariton, Christian, Clark, Clay, Clinton, Cole, Cooper, Crawford, Dade, Dallas, Daviess, DeKalb, Douglas, Franklin, Gasconade, Gentry, Greene, Grundy, Harrison, Henry, Hickory, Holt, Howard, Howell, Jackson, Jasper, Jefferson, Johnson, Knox, Laclede, Lafayette, Lawrence, Lewis, Lincoln, Linn, Livingston, Macon, Maries, Marion, McDonald, Mercer, Miller, Mississippi, Moniteau, Monroe, Montgomery, Morgan, New Madrid, Newton, Nodaway, Osage, Ozark, Pemiscot, Perry, Pettis, Phelps, Pike, Platte, Polk, Pulaski, Putnam, Ralls, Randolph, Ray, Saline, Schuyler, Scotland, Scott, Shelby, St. Charles, St. Clair, St. Francois, St. Louis, Ste. Genevieve, Stoddard, Stone, Sullivan, Taney, Texas, Vernon, Warren, Washington, Wayne, Webster, Worth, Wright, St. Louis City	IA

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
			Adair, Andrew, Atchison, Barry, Barton, Bates, Benton, Boone, Buchanan, Caldwell, Callaway, Camden, Cape Girardeau, Carroll, Cass, Chariton, Christian, Clark, Clay, Clinton, Cole, Cooper, Crawford, Dade, Dallas, Daviess, DeKalb, Douglas, Franklin, Gasconade, Gentry, Greene, Grundy, Harrison, Henry, Holt, Howard, Jackson, Jefferson, Johnson, Knox, Laclede, Lafayette, Lawrence, Lewis, Lincoln, Linn, Livingston, Macon, Maries, Marion, McDonald, Mercer, Miller, Mississippi, Moniteau, Monroe, Montgomery, Morgan, New Madrid, Newton, Nodaway, Osage, Ozark, Pemiscot, Perry, Pettis, Pike, Platte, Polk, Pulaski, Putnam, Ralls, Ray, Saline, Schuyler, Scotland, Shelby, St. Charles, St. Clair, St. Louis, Ste. Genevieve, Stone, Sullivan, Texas, Warren, Worth, Wright, St. Louis City	PA
December 1, 1993	DR 1006	Flooding, Severe Storm, Tornadoes	Bollinger, Butler, Cape Girardeau, Carter, Crawford, Dent, Franklin, Howell, Iron, Jefferson, Madison, Oregon, Perry, Pulaski, Reynolds, Ripley, Shannon, St. Francois, St. Louis, Ste. Genevieve, Stoddard, Texas, Washington, Wayne	IA
			Carter, Dent, Howell, Iron, Madison, Oregon, Perry, Reynolds, Shannon, St. Francois, Ste. Genevieve, Texas, Washington, Wayne	PA
April 21, 1994	DR 1023	Severe Storm, Flooding, Tornadoes	Barry, Callaway, Clay, Cole, Franklin, Jefferson, Lincoln, Morgan, Pemiscot, Phelps, Pulaski, Reynolds, Shannon, St. Charles, St. Louis, Vernon, Washington, St. Louis City	IA

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
June 2, 1995	DR 1054	Severe Storm, Tornadoes, Hail, Flooding	Adair, Andrew, Atchison, Barry, Barton, Bates, Benton, Boone, Callaway, Camden, Cape Girardeau, Carroll, Cass, Chariton, Clark, Cole, Cooper, Dallas, Daviess, DeKalb, Franklin, Gasconade, Gentry, Henry, Howard, Jackson, Jasper, Jefferson, Johnson, Lafayette, Lewis, Lincoln, Linn, Macon, Maries, McDonald, Mercer, Miller, Mississippi, Moniteau, Montgomery, Morgan, New Madrid, Newton, Nodaway, Osage, Pemiscot, Perry, Ray, Saline, Scotland, Scott, St. Charles, St. Clair, St. Francois, St. Louis, Ste. Genevieve, Stone, Sullivan, Vernon, Warren, St. Louis City	IA
			Andrew, Atchison, Barry, Bates, Benton, Boone, Callaway, Cape Girardeau, Carroll, Chariton, Clark, Cole, Cooper, Daviess, DeKalb, Franklin, Gasconade, Gentry, Henry, Howard, Jefferson, Johnson, Lafayette, Linn, Macon, McDonald, Mercer, Miller, Mississippi, Moniteau, Montgomery, Nodaway, Perry, Ray, Saline, St. Charles, St. Clair, St. Louis, Ste. Genevieve, Stone, Sullivan, Vernon, Warren	PA
October 14, 1998	DR 1253	Severe Storm and Flooding	Carroll, Clay, Jackson, Platte, Ray	IA
			Andrew, Barton, Caldwell, Carroll, Cedar, Chariton, Clay, Dade, DeKalb, Jackson, Linn, Livingston, Macon, Miller, Moniteau, Morgan, Platte, Polk, Ray	PA
Oct. 19, 1998**	DR 1256	Severe Storm and Flooding	Jackson, St. Louis, St. Louis City	IA
April 20, 1999	DR 1270	Severe Storms and Flooding	Andrew, Cole, Iron, Macon, Madison, Osage	IA
May 12, 2000	DR 1328	Severe Thunderstorms and Flash Flooding	Crawford, Franklin, Jefferson, Gasconade, St. Charles, St. Francois, St. Louis, Ste. Genevieve, Warren, Washington	IA
			Franklin, Gasconade, Jefferson	PA

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
May 6, 2003	DR 1463	Severe Storms, Tornadoes, and Flooding	Barry, Barton, Bates, Benton, Bollinger, Buchanan, Camden, Cape, Cass, Cedar, Christian, Clay, Clinton, Cooper, Crawford, Dade, Dallas, Dent, Douglas, Franklin, Knox, Gasconade, Girardeau, Greene, Henry, Hickory, Iron, Jackson, Jasper, Jefferson, Johnson, Laclede, Lafayette, Lawrence, McDonald, Miller, Monroe, Morgan, Newton, Osage, Perry Pettis, Phelps, Platte, Polk, Pulaski, Ray, St. Francois, St. Louis, Ste. Genevieve, Saline, Scott, St. Clair, Stoddard, Stone, Taney, Vernon, Washington, Webster	IA
			Bollinger, Crawford, Franklin, Gasconade, Knox, Maries, Miller, Oregon, Osage, Pulaski, Washington	PA
June 11, 2004	DR 1524	Severe Storms, Tornadoes, and Flooding	Adair, Andrew, Bates, Benton, Caldwell, Carroll, Cass, Cedar, Chariton, Clay, Clinton, Daviess, DeKalb, Gentry, Grundy, Harrison, Henry, Hickory, Jackson, Johnson, Knox, Linn, Livingston, Macon, Mercer, Monroe, Nodaway, Platte, Polk, Randolph, Ray, Shelby, St. Clair, Sullivan, Vernon, Worth	IA
March 16, 2006	DR 1631	Severe Storms, Tornadoes, and Flooding	Bates, Benton, Boone, Carroll, Cass, Cedar, Christian, Cooper, Crawford, Greene, Henry, Hickory, Howard, Iron, Jefferson, Johnson, Lawrence, Lincoln, Mississippi, Monroe, Montgomery, Morgan, New Madrid, Newton, Perry, Pettis, Phelps, Putnam, Randolph, St. Clair, Ste. Genevieve, Scott, Saline, Taney, Vernon, Webster, Wright	IA
			Bates, Bollinger, Benton, Boone, Carroll, Cedar, Christian, Daviess, Greene, Henry, Hickory, Howard, Iron, Lawrence, Monroe, Montgomery, Morgan, Perry, Pettis, Putnam, Randolph, Ray, Saline, St. Clair, Vernon, Washington, Webster, Wright	PA
April 5, 2006	DR 1635	Severe Storms, Tornadoes, and Flooding	Andrew, Butler, Dunklin, Pemiscot, St. Francois, Stoddard	IA
			Andrew, Jefferson, Pemiscot, Pettis, St. Francois	PA

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
January 15, 2007	DR 1676	Severe Winter Storms and Flooding	Barry, Barton, Benton, Boone, Callaway, Camden, Cedar, Christian, Cole, Crawford, Dade, Dallas, Dent, Franklin, Gasconade, Greene, Hickory, Jasper, Laclede, Lawrence, Lincoln, Maries, McDonald, Miller, Montgomery, Newton, Osage, Phelps, Polk, Pulaski, St. Charles, St. Clair, St. Louis, Stone, Texas, Warren, Webster, Wright Counties, St. Louis City	PA

Source: Federal Emergency Management Agency, State Emergency Management Agency
Note:
*IA denotes Individual Assistance; PA denotes Public Assistance

Ranking among the state's most notable flood disasters are the Missouri River flood of 1927, which spread destruction across 17 million acres, and the flood of 1951, which caused an estimated $400 million in damage. Record flooding also occurred in 1973 along the Mississippi River, where backwater inundated 474,000 acres at a loss of $40 million. The unseasonably heavy rainfall produced severe headwater flooding along many of the area's tributary streams, particularly in the St. John's Basin in Missouri and along the St. Francis and White Rivers in Arkansas. Of special historic interest is the December 1982 flood that spread dioxin-contaminated soil in the Times Beach area near St. Louis and led to a federal buyout of the entire town. In the fall of 1986, record flooding returned in Missouri, as well as in Michigan, Illinois, Kansas, and Oklahoma, with all these states declared federal disaster areas. Significant flooding next occurred in the state in the spring of 1990, particularly along the Missouri River in western, central, and portions of eastern Missouri. Record-level, repetitive flooding occurred from 1993 through 1995, and flash flooding ravaged several areas of the state in July and October 1998. In the springs of 1999 and 2000, flash flooding and severe storms again battered portions of the state.

Floods of 1993–1995

The floods of 1993 through 1995 represent Missouri's worst repetitive flood events. Within this time frame, there were five presidential disaster declarations, including four in just one 12-month period. This period extended from May 11, 1993, when the first declaration was issued by President Clinton, through April 21, 1994, when the fourth declaration was approved. Flooding in the spring of 1995 resulted in a fifth disaster declaration, issued on June 2, 1995.

The ravages of these floods left a legacy of destruction, human suffering, and property damage of unprecedented terms in Missouri history. The fact that Missouri would need several years to recover from these repetitive flood disasters was undisputed.

In 1993 alone, a total of 112 of Missouri's 114 counties were included in at least one or more of the declarations. Only Cedar County in southwest Missouri and Dunklin County in the southeast portion of the state were not included in any of the 1993 declarations.

A number of flood-level records were broken in 1993 and, in the U.S. Corps of Engineers' St. Louis and Kansas City Districts, 867 of 947 federal and nonfederal levees failed or were overtopped and greatly contributed to the flooding. The Missouri River, normally no more than a half-mile wide, expanded to 5-6 miles wide north of St. Joseph and 8-10 miles wide east of Kansas City. Just north of St. Louis, it reached 20 miles wide near its confluence with the Mississippi. As a result, almost half of the 620 square miles of St. Charles County were underwater. Tables 3.26 and 3.27 highlight high-water stages and levee failures that resulted from the summer flood of 1993.

Table 3.26. Record High-Water Stages in Missouri during the Summer 1993 Flood (in feet)

River	1993 Level	Previous Record	Flood Stage
Mississippi River			
Hannibal	31.8	28.6	16
St. Louis	49.4	43.3	30
Cape Girardeau	48.0	45.6	32
Missouri River			
St. Joseph	32.7	26.8	17
Kansas City	48.9	46.2	32
Jefferson City	38.6	34.2	23
Hermann	36.3	35.8	21
St. Charles	39.5	37.5	25

Source: U.S. Army Corps of Engineers (1993)

Table 3.27. Distribution of Levee Failures by Corps of Engineers District/ Number of Failed or Overtopped Levees, Summer 1993 Flood

Corps of Engineers District	Federal Levees	Nonfederal Levees
St. Louis*	12 of 42	39 of 47
Kansas City**	6 of 48	810 of 810

Source: Natural Disaster Survey Report, "The Great Flood of '93."
Notes:
The difference in the failure rates above is because most federal levees are designed to withstand a 100- to 500-year flood, while nonfederal levees, predominantly protecting agricultural lands, are frequently designed for a flood with a return period of 50 years or less.
*Includes eastern Missouri and portions of Illinois
**Includes northwestern, west-central, and portions of southwest Missouri and areas in Kansas and Nebraska

Figures 3.29 through 3.34 illustrate the extent of the 1993–1995 floods.

Figure 3.29. Spring 1993 Flood

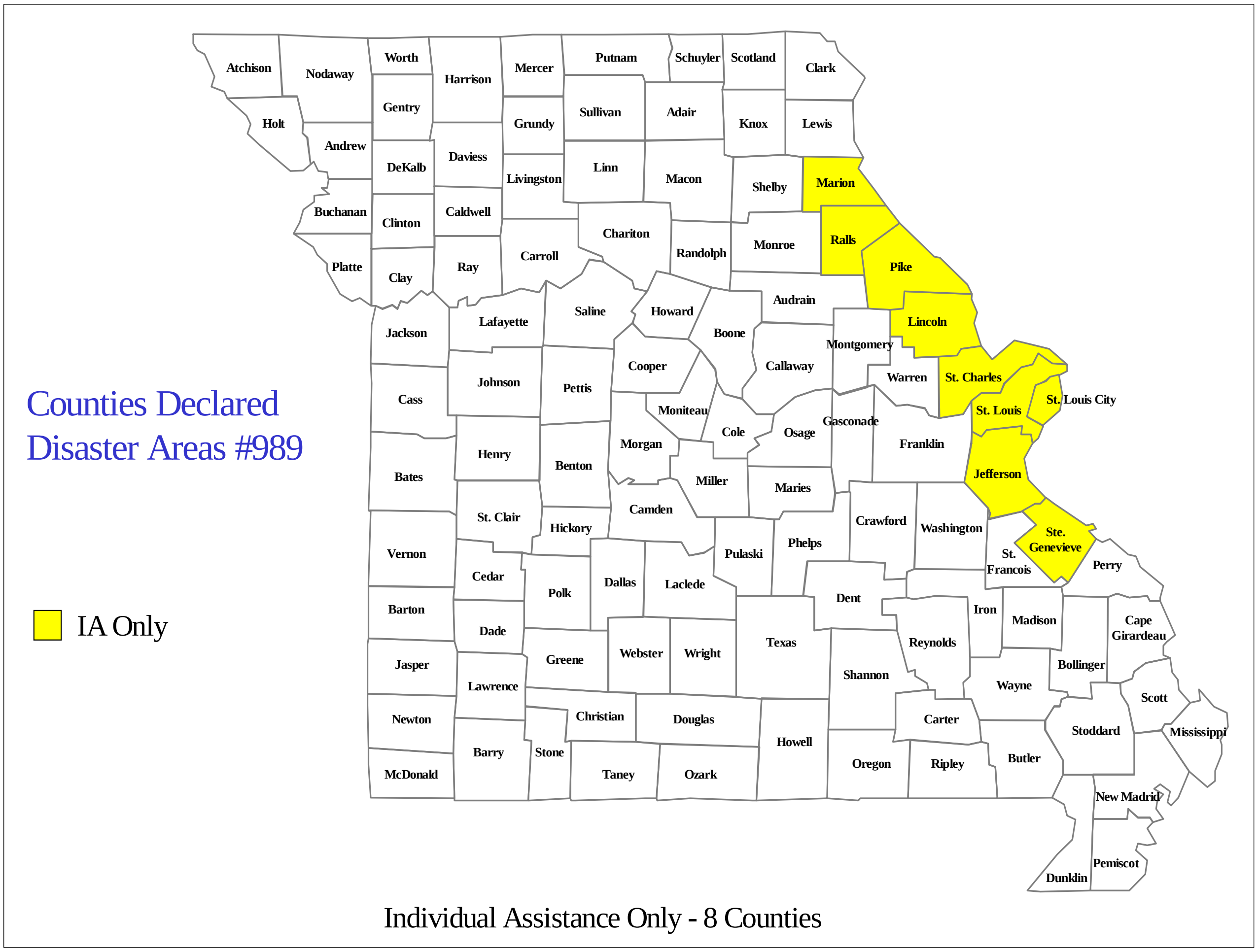


Figure 3.30. Summer 1993 Flood

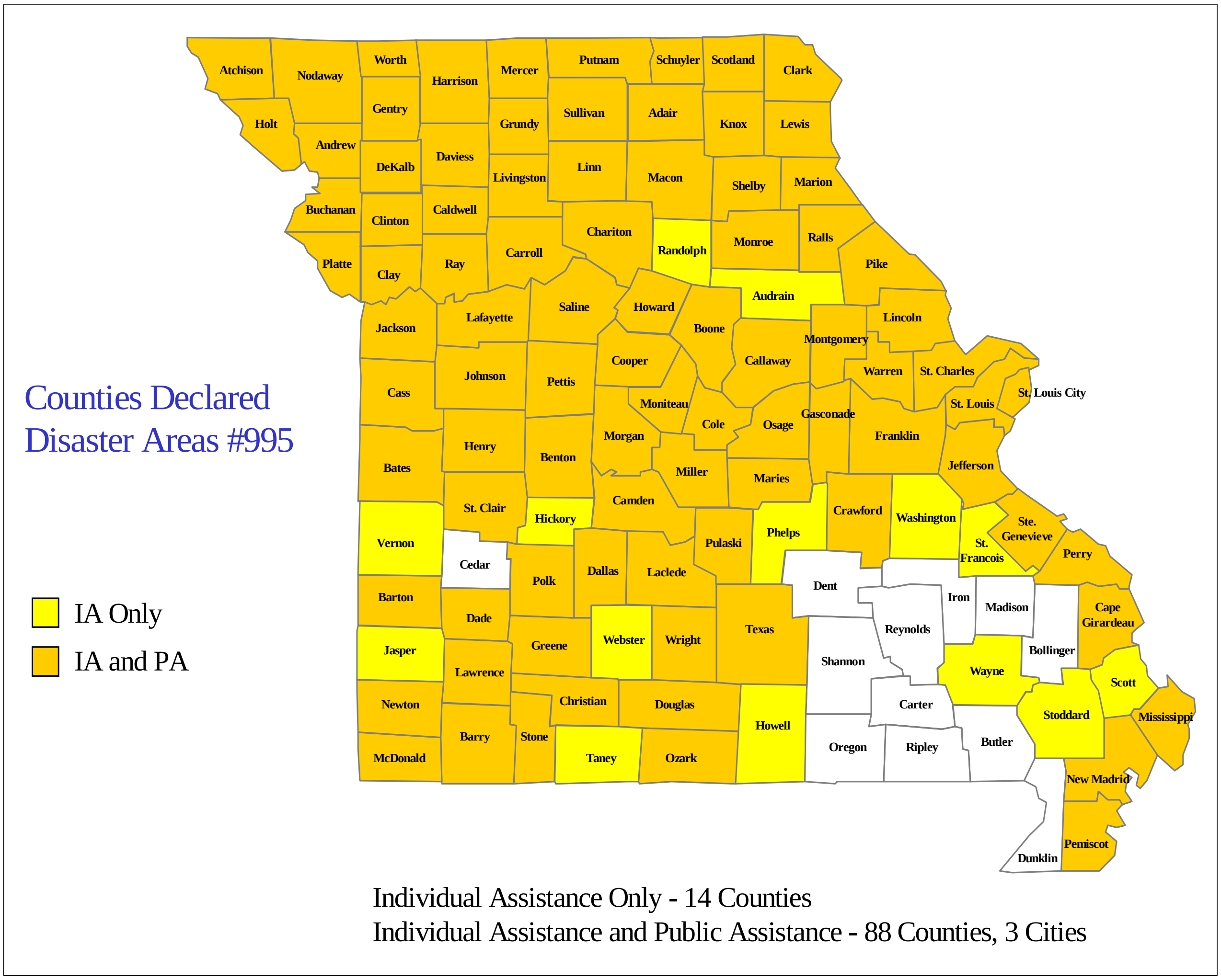
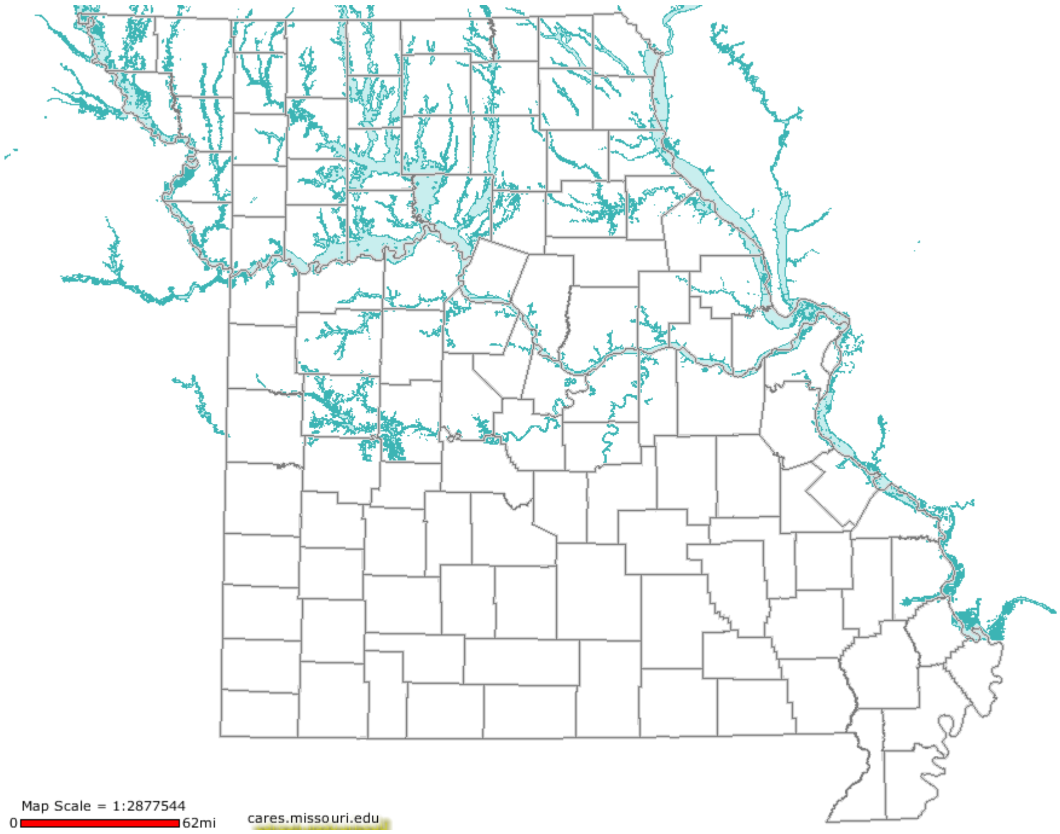
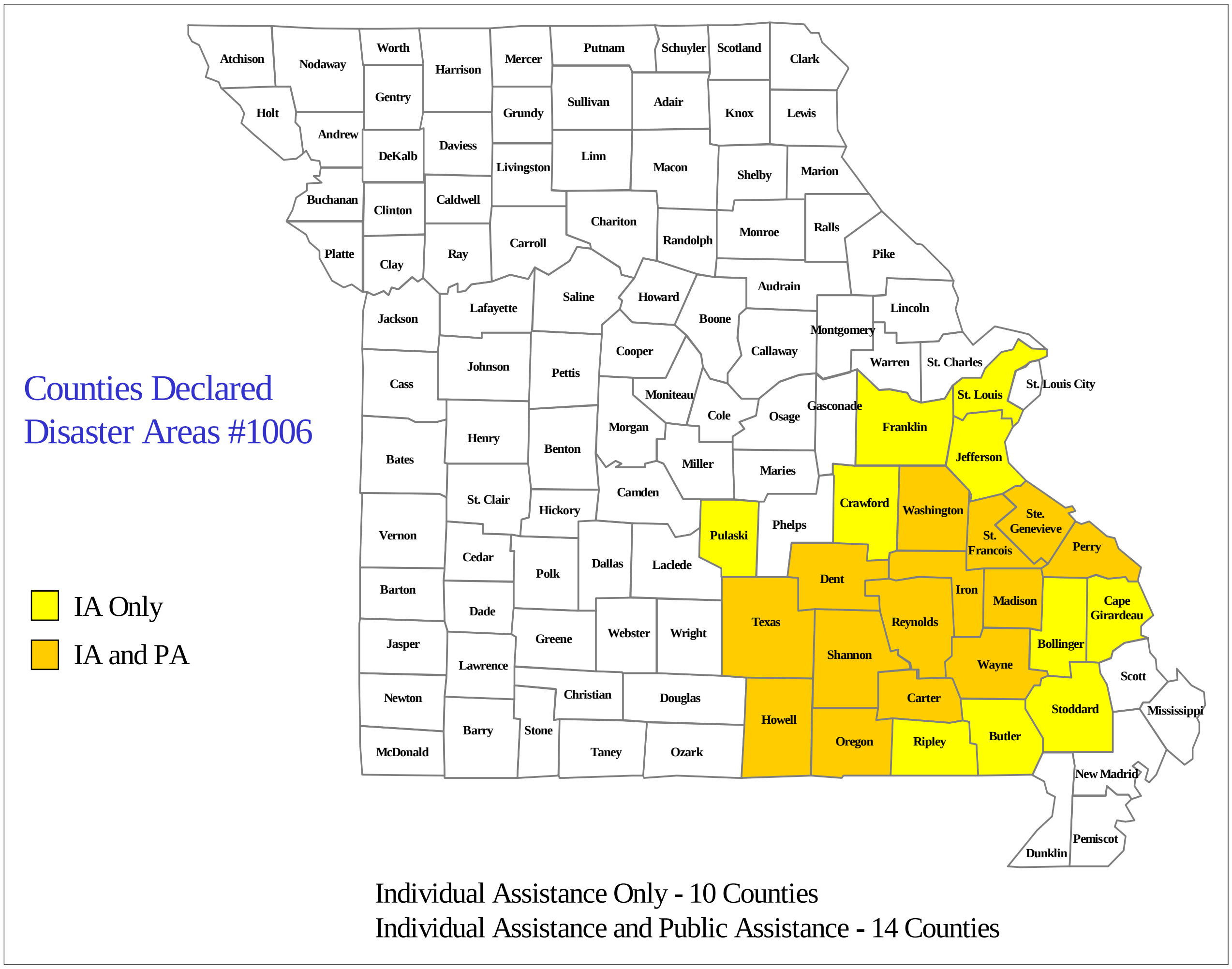


Figure 3.31. Extent of Summer 1993 Flood



Source: University of Missouri Center for Agricultural, Resource, and Environmental Systems

Figure 3.32. Fall 1993 Flood



Individual Assistance Only - 10 Counties
Individual Assistance and Public Assistance - 14 Counties

Figure 3.33. Spring 1994 Flood

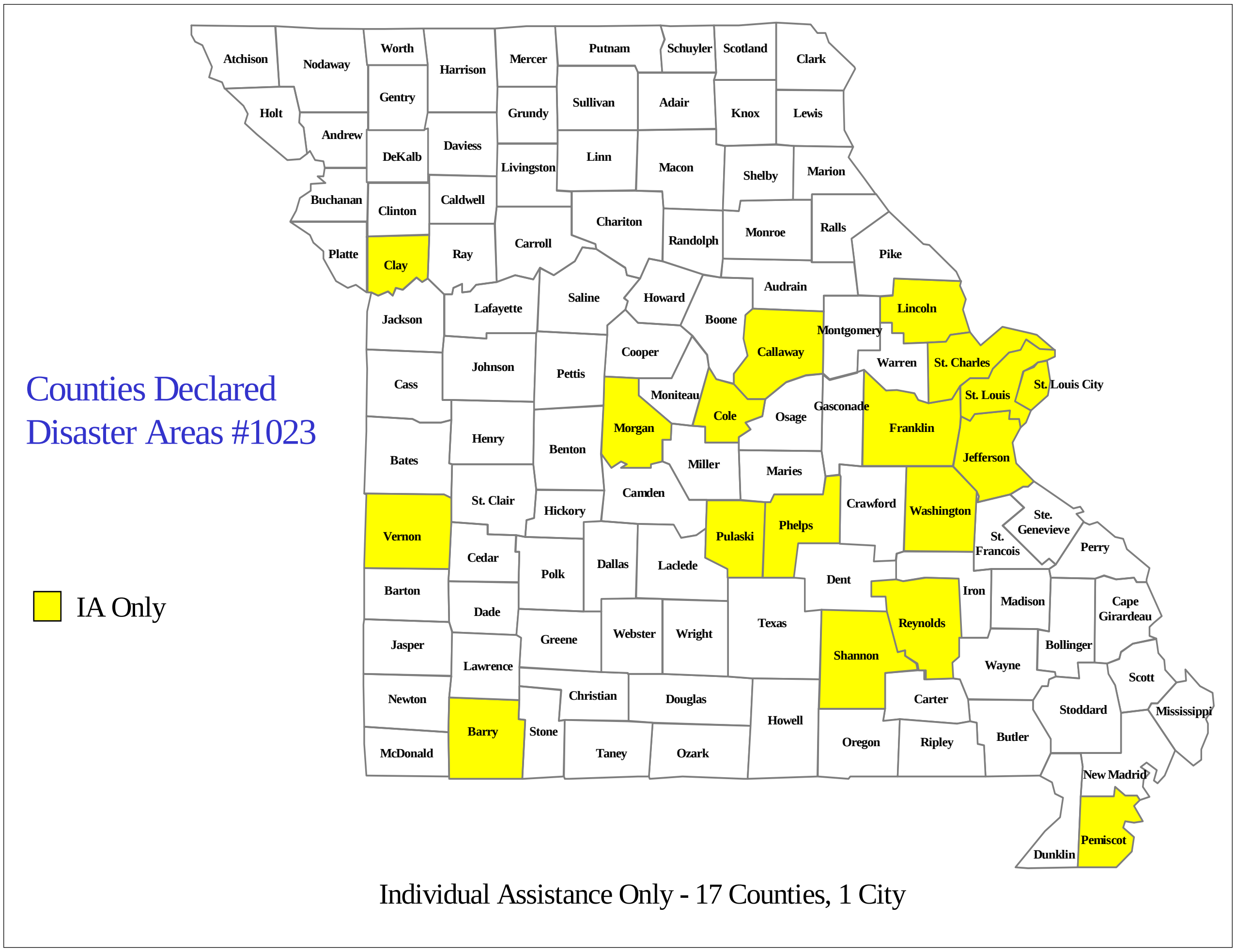
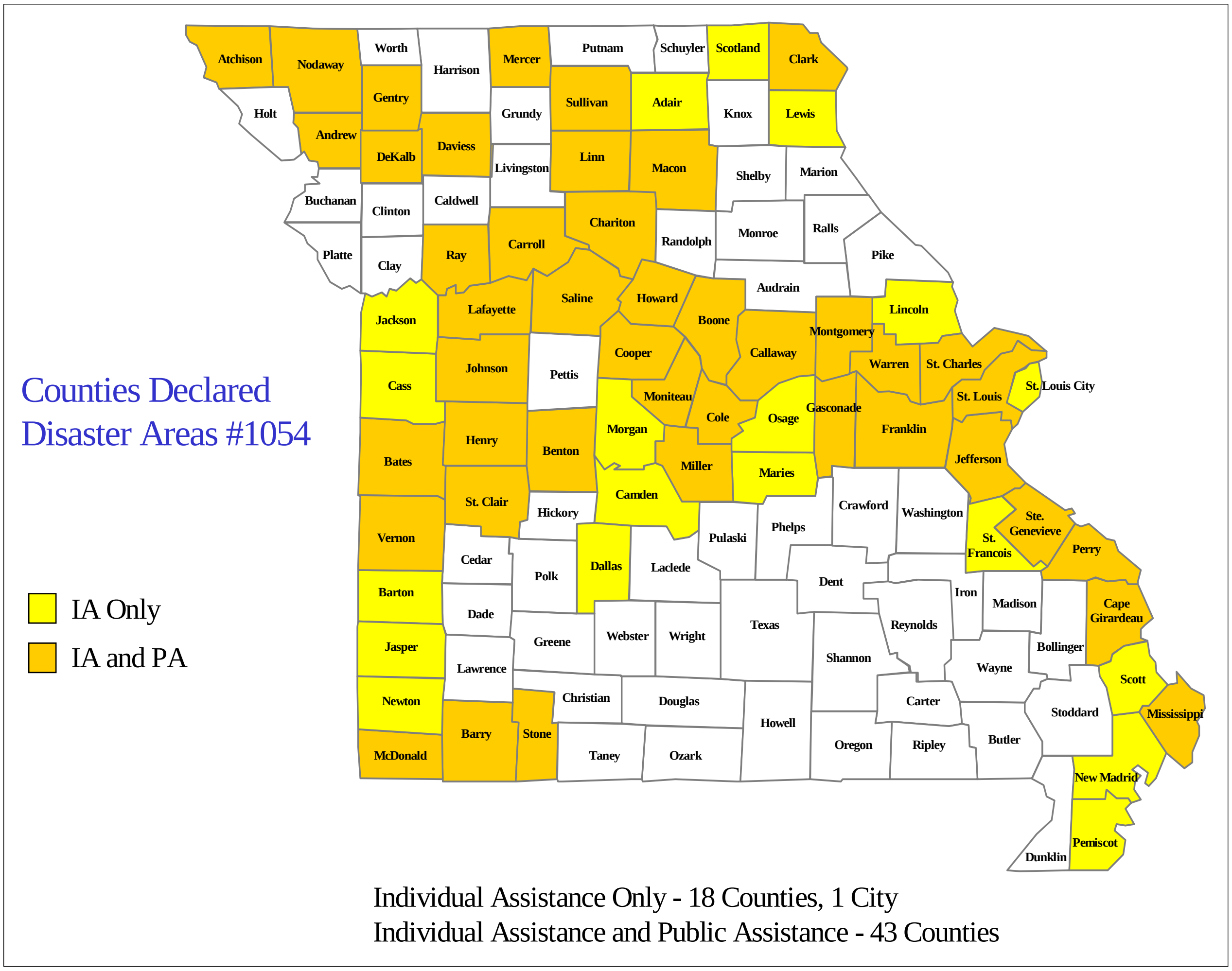


Figure 3.34. Spring 1995 Flood



Floods of 1998

Severe flash flooding in the summer and fall of 1998 took a heavy toll in terms of lives lost and extensive property damage in several areas of the state. In all, at least 17 people died as a result of the two flood events. Almost all of the casualties occurred when people attempted to drive their vehicles through rushing water, overturned their vehicle into floodwaters, or were trapped and swept off a flooded bridge. Both flood incidents ultimately resulted in presidential disaster declarations to provide state and federal assistance in the declared counties (see Figures 3.35 and 3.36).

Figure 3.35. July 1998 Flood

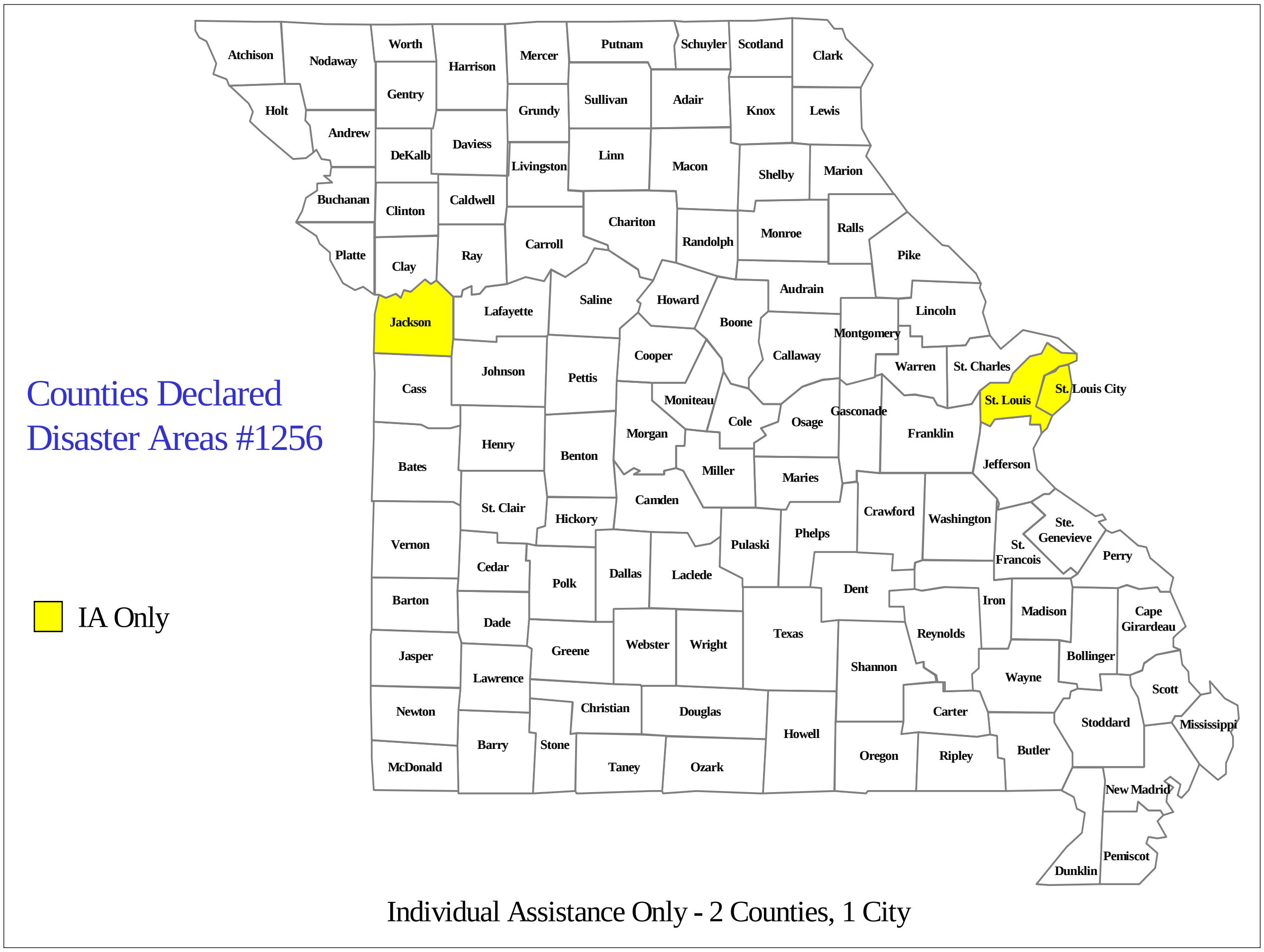
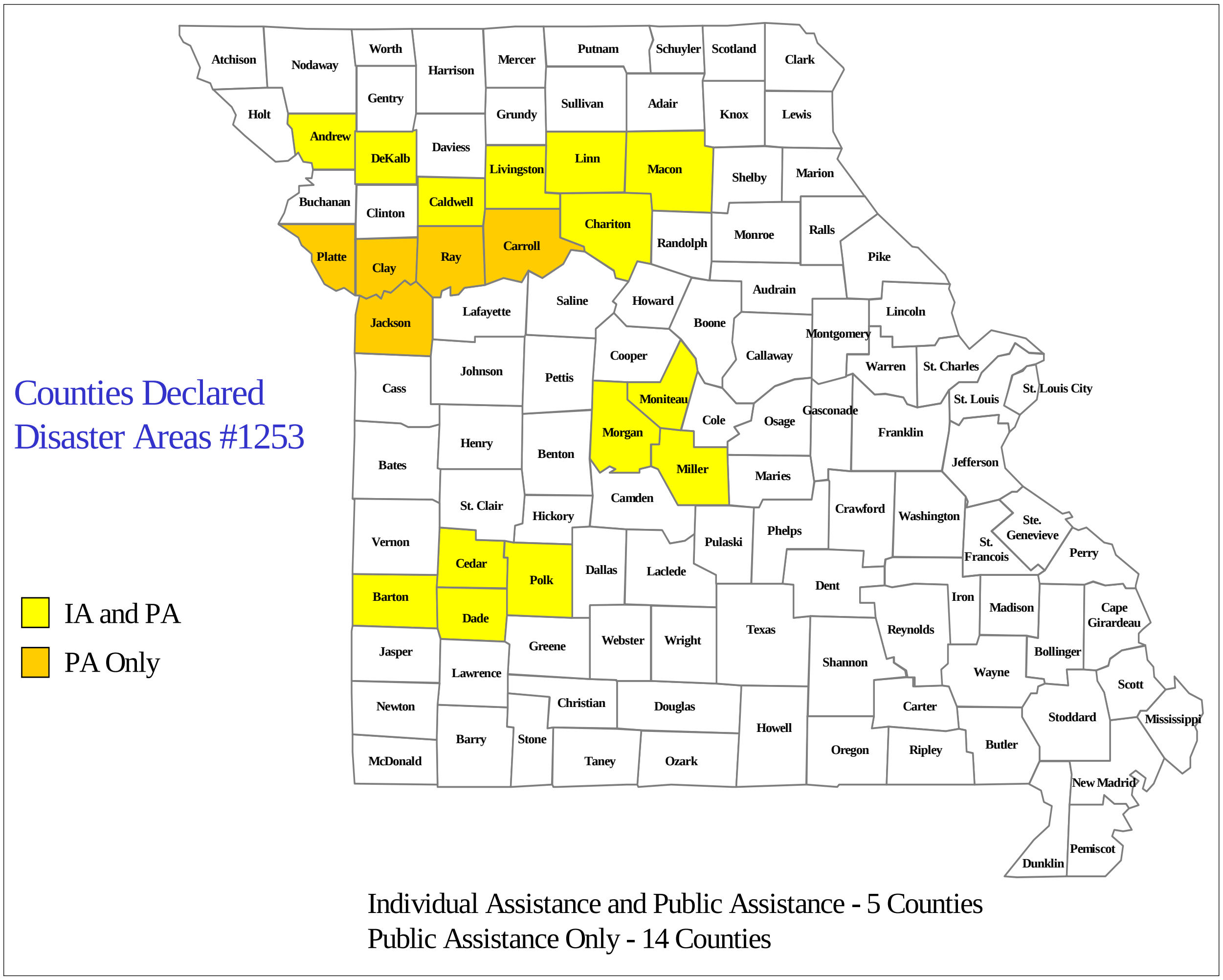


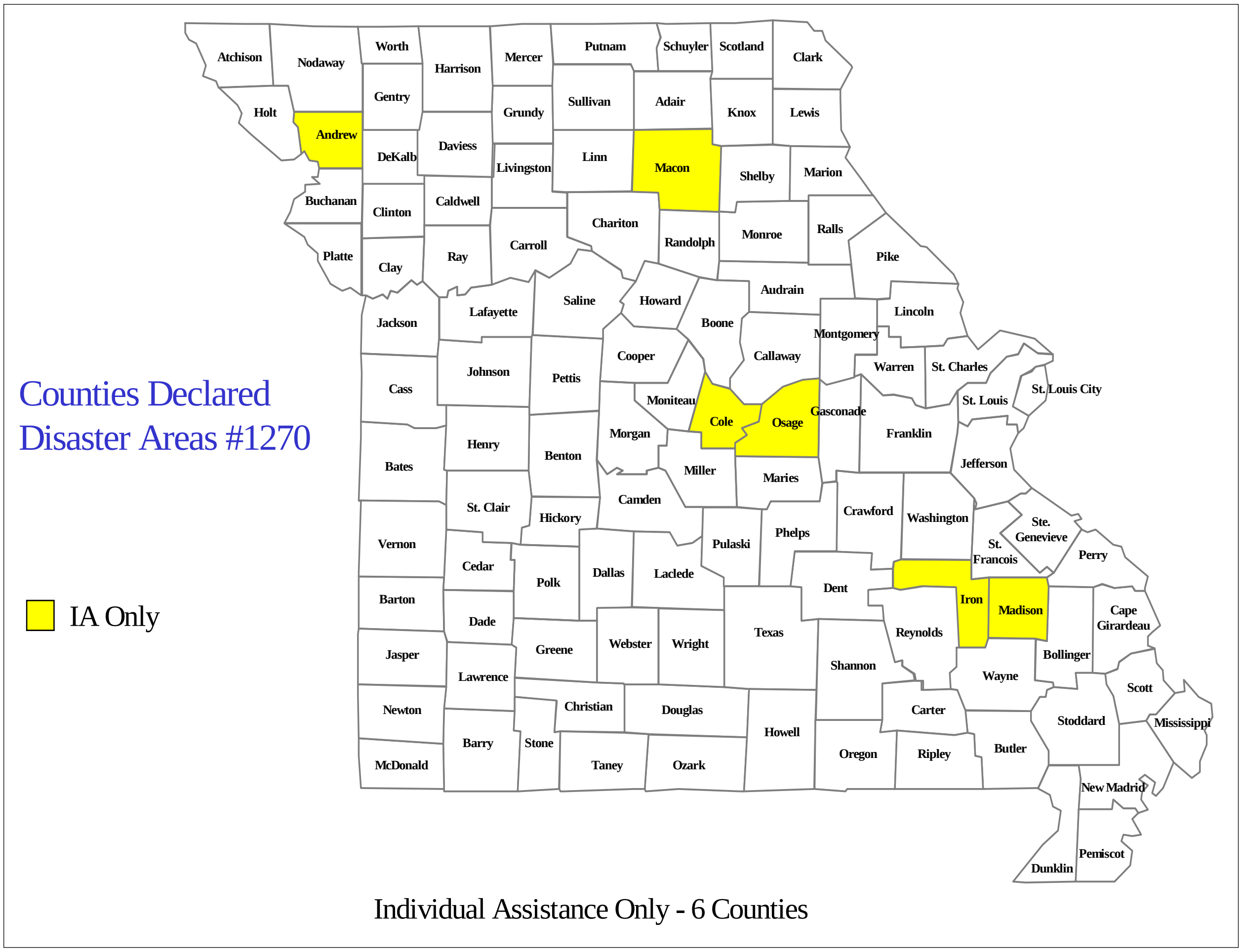
Figure 3.36. Fall 1998 Flood



Spring 1999 and 2000 Floods

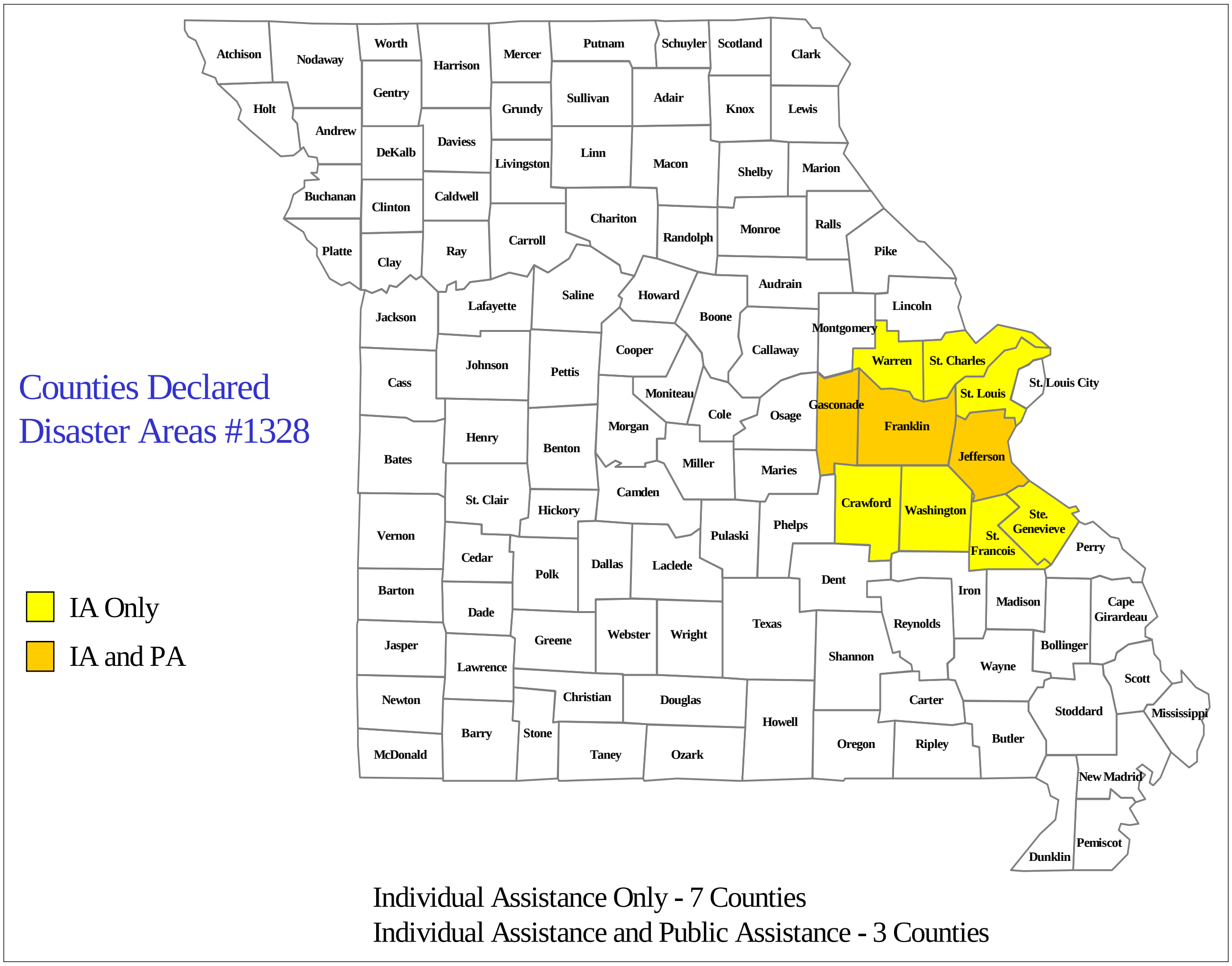
On April 3, 1999, a heavy rainstorm in southeast Missouri caused severe flash flooding in Madison County, including the communities of Fredericktown and Marquand. One death (due to electrocution) was attributed to that flood event when 7 to 10 inches of rain fell over a two-hour period, causing the St. Francois River to crest at twice the height of flood stage. More than 400 homes were adversely affected, with nearly half receiving significant water damage within the living spaces. Seven businesses were damaged, and five were determined to be destroyed. On April 20, 1999, a presidential disaster declaration for individual assistance (DR 1270) was approved for Madison County and five additional counties (Andrew, Cole, Osage, Iron, and Macon) were later approved by FEMA as add-ons to that declaration as a result of subsequent tornadoes and storms (see Figure 3.37). More than 30 Missouri counties were also designated as eligible for disaster relief for agricultural losses suffered from the April storms.

Figure 3.37. Spring 1999 Flood and Storms



For two consecutive spring seasons, Missouri experienced devastating flash flooding that forced hundreds of people from their homes and caused millions of dollars in property damage to both homes and businesses. Although the flash flooding in both events was confined to a few areas, the type of devastation was equal or greater than some of Missouri's worst river flooding events. On May 6 and 7, 2000, a slow-moving storm unleashed 15 inches of rain in Franklin and Jefferson counties in less than 24 hours. The city of Union in Franklin County was among the hardest hit due to extreme flooding from Flat Creek. In all, 10 counties were included in a presidential disaster declaration (DR 1328) issued on May 12, 2000 (see Figure 3.38). Three counties were declared eligible for Public Assistance and Individual Assistance, and seven others were declared for Individual Assistance.

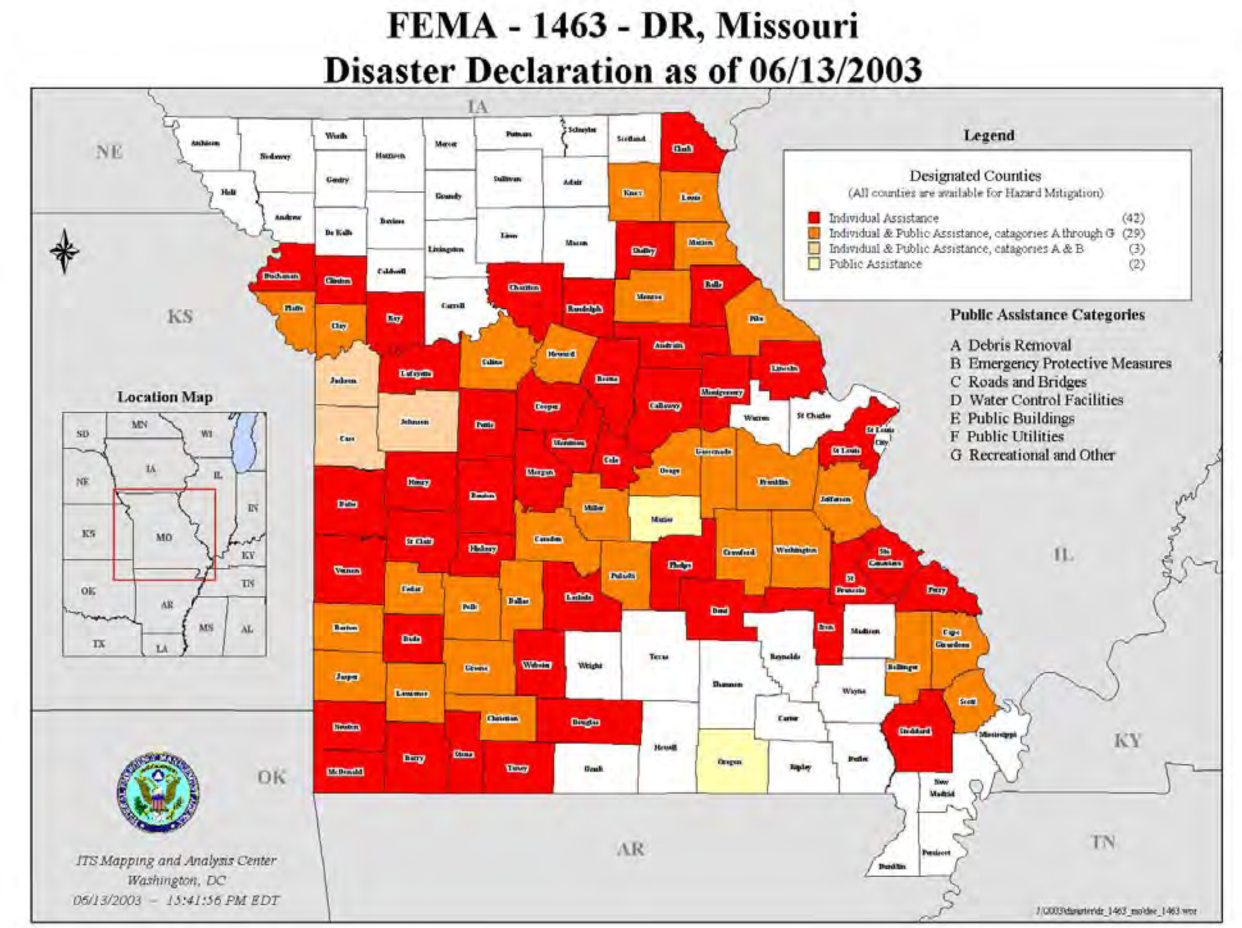
Figure 3.38. Spring 2000 Flood



Spring 2003 Flood

Flash flooding occurred on May 7 and 8, 2003, and became a major flooding event across all of southern and central Missouri through the early afternoon of May 9. In addition to the numerous road closures; bridges blocked by debris; evacuations of towns, campgrounds, and parks; and moderate river flooding, many communities had their worst flooding in more than 10 years. In Howell County, the most significant damage occurred after the Warm Fork River washed out a portion of train track four miles southeast of West Plains, resulting in a train derailment. Four locomotives, each weighing 260,000 pounds, and 10 railroad cars were knocked off the tracks allowing diesel fuel to flow freely onto the ground. In addition to all of the flash flooding reports, river flooding became significant as all of the southern Missouri rivers rose above flood stage by the middle of May. Some of the rivers crested at levels equivalent to the 1993 flood event. Figure 3.39. illustrates the counties that received disaster declarations.

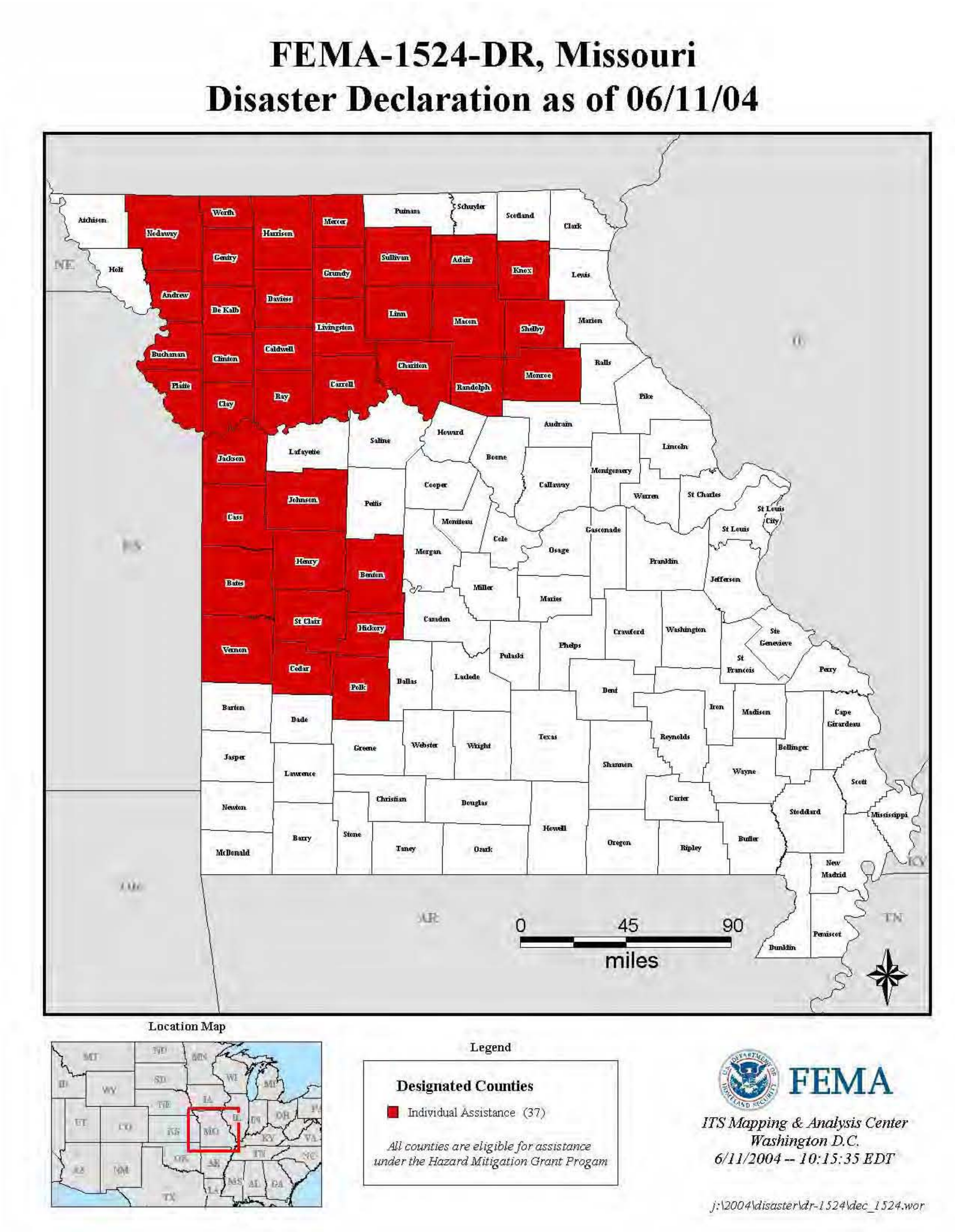
Figure 3.39. Spring 2003 Flood



Flood of 2004

The month of May 2004 saw severe storms containing heavy rains and large hail. A strong storm moved through the state from west to east, roughly along the Interstate 70 corridor, during the night of May 18–19, 2004. The most severe hit area appeared to be in Cass County south of Kansas City. Twenty-two homes were evacuated in Freeman and Lake Annett in Cass County as a result of major flash flooding. Figure 3.40. illustrates the counties that received disaster declarations.

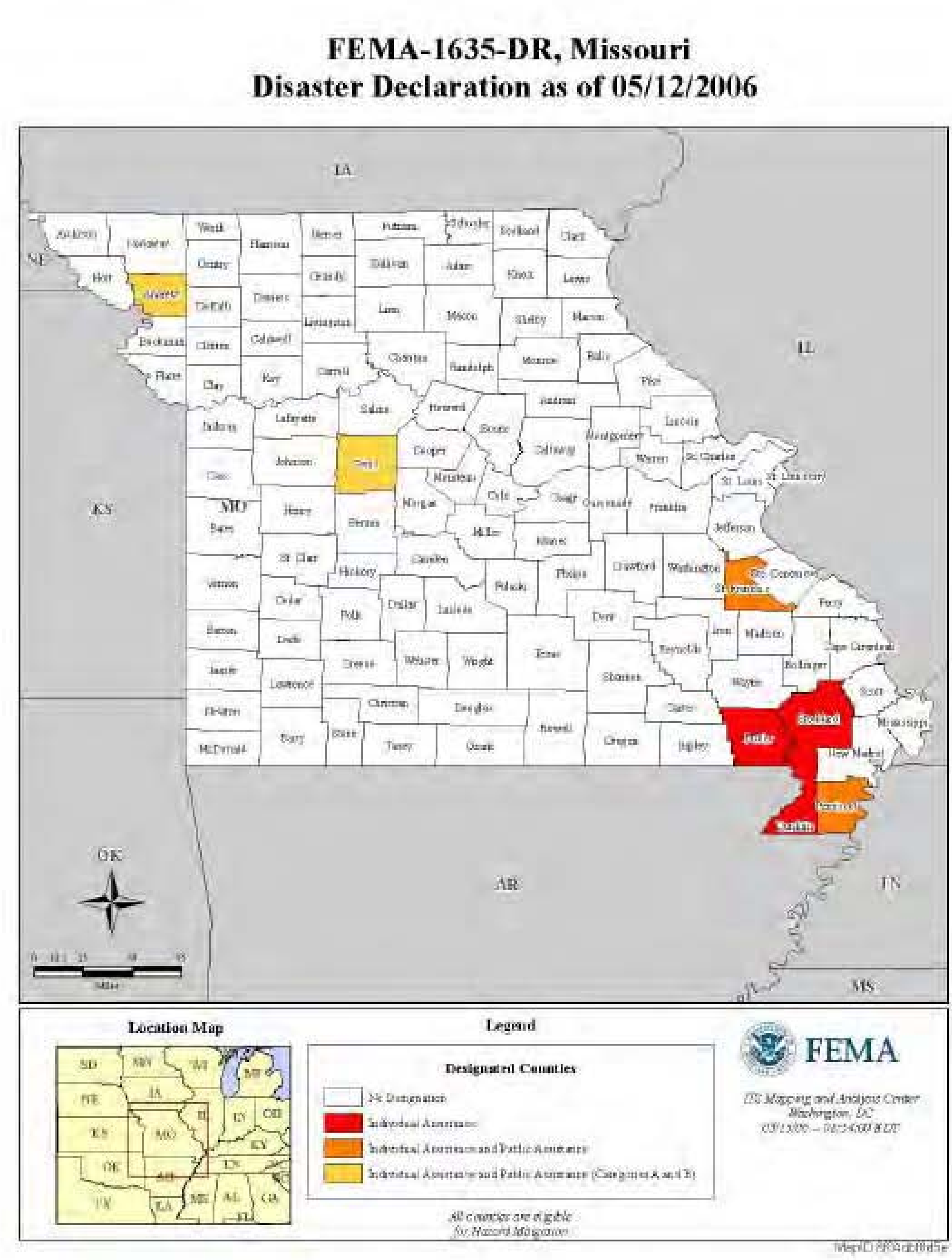
Figure 3.40. Spring 2004 Flood



Spring 2006 Flood

Counties that received disaster declarations for a flood in May 2006 are illustrated in Figure 3.41.

Figure 3.41. Spring 2006 Flood



Spring 2007 Flood—Preliminary Information

Just before the 2007 plan update went to press, a line of severe spring thunderstorms swept across western Missouri on Sunday, May 6, 2007, bringing with it heavy rains, high winds, and some hail. The storms resulted in near-record flooding in northwest Missouri along the Missouri River and its tributaries. Impacts included evacuations, road closures, bridge damage, broken water mains, and damage to homes and businesses, some of which were destroyed. Numerous levees broke or were overtopped in Carroll, Chariton, Clay, Jackson, Holt, Ray, and Saline counties. Some of the worst damage was in Big Lake in Holt County, where more than 450 homes were flooded.

Measure of Probability and Severity

Probability: High
Severity: High

In terms of overall damage, Missouri's most severe single hazard is flooding. While the state averages some 28 tornadoes each year, damage is generally confined to small areas with few fatalities, if any. By contrast, flooding has resulted in more federal disaster declarations in Missouri than any other hazard in the past three decades. Prior to the Great Flood of 1993, Missouri received major disaster declarations due to flooding in the spring of 1990, October 1986, June 1984, December 1982, August 1982 (Jackson County), April 1979, September 1977, May 1977, July 1976, June 1974, and for extensive flooding in April 1973 and again in November 1973.

Missouri's vulnerability to flooding is greatly increased because it is subject to flooding from two principal sources: the Missouri River Basin and the Upper Mississippi River Basin. Over one-third of the annual monetary losses due to flooding in the Missouri River Basin occur in Missouri.

Flash flooding can occur virtually anywhere in the state experiencing an abundance of rainfall in a very short time span, as with the November 1993 flood disaster and floods of 1998 and 1999. The backing up of tributary streamflows creates flooding problems along the Mississippi River, especially in the southern area of the state where the land tends to be very flat and at low elevations. Even though many flood control projects have been implemented and directly aid in flood prevention, the state is still flood-prone due to its geography and location.

The National Weather Service has three response levels for alerting the public as to the danger of floods, as described in Table 3.28.

Table 3.28. National Weather Service Flood Response Levels/Activities

Response Level	Activity
Flood Watch	Flash flooding or flooding is possible within the designated area.
Flood Warning	Flash flooding or flooding has been reported or is imminent. Necessary precautions should be taken at once.
Flood Advisory	Flooding of small streams, streets, and low-lying areas, such as railroad underpasses and urban storm drains, is occurring.

The threat of flooding is more likely in the spring, when late winter or spring rains, coupled with melting snow, fill river basins with too much water too quickly. Spring also represents the onset of severe weather in the form of thunderstorms, tornadoes, and heavy rains, which can generate flash flooding along these storm fronts. However, as demonstrated by the disaster declarations in December 1982 and the Great Flood of 1993, severe flooding can occur in Missouri at any time of the year. Based on this information, the state rates the probability and severity of floods as high.

Impact of the Hazard

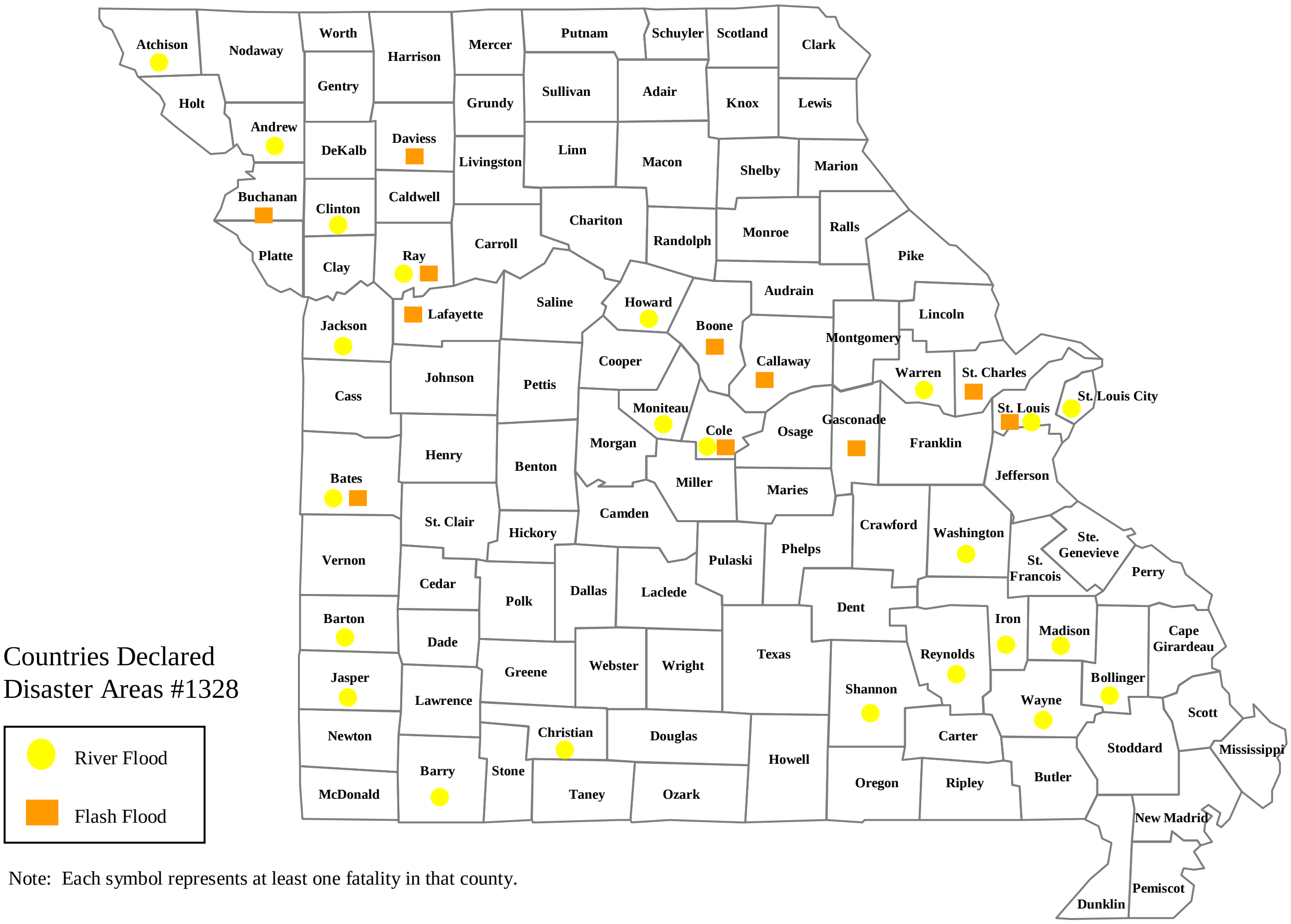
The Federal Emergency Management Agency estimates that more than 216,000 households are within designated floodplains in Missouri. In addition, thousands of other Missouri residents are at risk to the dangers of flash flooding from rapidly rising creeks and tributaries, storm water runoff, and other similar flooding events. Nationwide, most flood deaths are from flash floods, and nearly half of these fatalities are auto-related, according to the National Weather Service.

Of the 49 deaths recorded during the floods of 1993, 35 (71 percent) were from flash floods. In that same category, 20 deaths (77 percent) were related to motor vehicles caught in flash floods. Missouri's river flooding in 1993 claimed 14 lives, with 6 deaths (23 percent) attributed to motor vehicles (see Table 3.29 and Figure 3.42).

Table 3.29. Summer/Fall 1993 Causes of Death by Type of Flood

Type of Death	River Flood	Flash Flood	Total
Motor Vehicle	6 (23%)	20 (77%)	26 (53%)
Drowning	5 (25%)	14 (74%)	19 (39%)
Electrocution	1 (50%)	1 (50%)	2 (4%)
Cardiac	2 (100%)	0	2 (4%)
All Causes	14 (29%)	35 (71%)	49 (100%)

Figure 3.42. Flood-Related Mortality Missouri 1993



Note: Each symbol represents at least one fatality in that county.

Missouri flood disasters have inflicted tremendous loss in terms of damage to personal property, businesses, infrastructure/public property, and agriculture. Total losses during the 1993 flood disasters were estimated at approximately $3 billion. In addition, agricultural losses were estimated at $1.8 billion, as 3.1 million acres of farmland were either damaged or went unplanted because of the 1993 rains. The U.S. Department of Agriculture estimated that 445,000 acres of Missouri River bottomland were destroyed by washouts and sand scouring. While levees designed to protect up to 50-year floods did their jobs, the amount of rain and up-river flooding took their toll. Of the 1,456 public and private levees in the state, approximately 840 were damaged.

Almost every Missourian was at some time affected by the 1993 floods through inundation of roadways, airports, and drinking water and sewage treatment facilities, and by loss of income. The Missouri Department of Labor and Industrial Relations reported that $6.2 million was disbursed for disaster unemployment assistance for people who lost work due to flooding from July 1993 through March 1994.

The floods of 1993 and 1994 pointed out that too many Missourians were living in a floodplain. To rebuild in the floodplains, those whose homes sustained substantial damage (50 percent or more) were required to elevate the structures above the base-flood level to protect from future flood damage. Under Missouri's Community Buyout Program, more than $30 million in federal money was committed to moving Missourians voluntarily out of the floodplains through the acquisition of primary residential properties. As a result of those actions, it is estimated that state taxpayers will save more than $200 million in future flood disaster claims.

The information in Table 3.30 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.30. EMAP Impact Analysis: Flooding

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be severe for incident areas and moderate to light for other adversely affected areas.
Health and Safety of Personnel Responding to the Incident	Localized impact expected to limit damage to personnel in the flood areas at the time of the incident.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the area of the incident. Some severe damage possible.
Delivery of Services	Localized disruption of roads, facilities, and/or utilities caused by incident may postpone delivery of some services.
The Environment	Localized impact expected to be severe for incident areas and moderate to light for other areas affected by the flood or HazMat spills.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time.
Regulatory and Contractual Obligations	Regulatory waivers may be needed locally. Fulfillment of some contracts may be difficult. Impact may temporarily reduce deliveries.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

Floods are often accompanied by other types of severe weather, including tornadoes, lightning, and severe thunderstorm activity. These storms also present a danger to life and property, often resulting in many injuries, and in some cases, fatalities. Floodwaters themselves often interact

with hazardous materials. This has prompted the evacuation of many citizens near such materials stored in large containers that could break loose or puncture as a result of flood activity. Such events occurred during the 1993 flood, when approximately 11,000 St. Louis residents residing near flood-threatened propane tanks were evacuated on July 30. Evacuations were also ordered on July 31, when bulk propane tanks were flooded by the River Des Peres in St. Louis County. Federal and state agencies retrieved more than 247 large storage tanks; 1,178 small tanks; 3,470 large drums (over 15 gallons); and 5,731 small drums that had been swept away by the floods.

Public health concerns that may result from flooding include the need for disease and injury surveillance, community sanitation to evaluate flood-affected food supplies, private water and sewage sanitation, and vector control (for mosquitoes and other entomology concerns).

Separate sections quantify the potential riverine flooding losses to the state and its jurisdictions. These are Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction and Section 3.4 Assessing Vulnerability and Estimating Potential Losses of State Facilities.

3.2.8 Severe Winter Weather/Snow/Ice/Severe Cold

Description of Hazard

Severe winter weather, including snowstorms, ice storms, and extreme cold, can affect any area of Missouri. The greatest threat is likely to occur in the area north of the Missouri River, as with the devastating Kansas City area ice storm on January 31, 2002, which stretched into central Missouri and led to a presidential disaster declaration (DR 1403).

Severe weather, such as snow, ice storms, and extreme cold can cause injuries, deaths, and property damage in a variety of ways. Winter storms are considered deceptive killers. This is because most deaths are indirectly related to the storm. Causes of death range from traffic accidents due to adverse driving conditions such as icy roads, to heart attacks caused by overexertion while shoveling snow and from other related activities. Hypothermia or frostbite may be considered the most direct cause of death and injury that can be attributed to winter storms or severe cold.

Economic costs are also difficult to measure. Heavy accumulations of ice can bring down trees, electric power lines and poles, telephone lines, and communications towers. Power outages create an increased risk of fire, as home occupants use alternative fuel sources (wood, kerosene, etc. for heat and fuel-burning lanterns or candles for emergency lighting). These storms can also affect utility and city operations due to debris removal and landfill hauling. In the 2002 ice storm, one home burned when ice-laden tree limbs fell and tore the electrical junction box from the outside of the home. Electrical sparks ignited a blaze that destroyed the home.

Crops and trees can be damaged, and livestock can be killed or injured due to deep snow, ice, or severe cold. Buildings and automobiles may be damaged from falling tree limbs, power lines, and poles. Local governments, home and business owners, and power companies were faced

with spending millions of dollars to restore services, remove debris, and haul debris. Federal Public Assistance for local governments and Individual Assistance for citizens and businesses under helped cover much of the expense.

The types of watches and warnings during severe winter weather are listed below:

- **Winter Weather Advisory**—Winter weather conditions are expected to cause significant inconveniences and may be hazardous. If caution is exercised, these situations should not become life threatening. Often the greatest hazard is to motorists.
- **Winter Storm Watch**—Severe winter conditions, such as heavy snow and/or ice are possible within the next day or two.
- **Winter Storm Warning**—Severe winter conditions have begun or are about to begin.
- **Blizzard Warning**—Snow and strong winds will combine to produce a blinding snow (near zero visibility), deep drifts, and life-threatening wind chill.

Wind Chill Chart: In 2001, the National Weather Service (NWS) implemented a replacement Wind Chill Temperature (WCT) index for the 2001–2002 winter season (see Figure 3.43). The reason for the change was to improve the current WCT index used by the NWS and the Meteorological Services of Canada (the Canadian equivalent of the NWS), which was based on scientific research and a previous index from 1945.

Figure 3.43. Wind Chill Chart

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: National Weather Service

This formula makes use of advances in science, technology, and computer modeling to provide a more accurate, understandable, and useful formula for calculating the dangers from winter winds and freezing temperatures. In addition, clinical trials have been conducted, and the results of those trials have been used to verify and improve the accuracy of the new formula. The replacement WCT index:

- Uses wind speed calculated at the average height of the human body's face (5 feet), instead of the standard anemometer height (33 feet);
- Is based on a human face model;
- Incorporates modern heat transfer theory (heat loss from the body to its surroundings during cold and breezy/windy days);
- Lowers the calm wind threshold to 3 miles per hour;
- Uses a consistent standard for skin tissue resistance; and
- Assumes the worst-case scenario for solar radiation (clear night sky).

Historical Statistics

Weather data indicate that the Missouri counties north of the Missouri River receive an average annual snowfall of 18 to 22 inches. Counties south of the Missouri River receive an annual average of 8 to 12 inches. The events that involve borderline conditions of freezing rain and ice are highly unpredictable. The durations of the more serious events combined with other factors, such as high winds, are also highly unpredictable. The degree of severity may be localized to a small area due to a combination of climatic conditions.

Besides snow and ice, extremely cold temperatures can produce problems. The wind chill is determined by factoring cold temperatures and wind speed (see Figure 3.43). For example, when the temperature is 20°F and the wind speed is 15 miles per hour, the resulting wind chill (what it really feels like) is 6°F. This type of situation can be dangerous to people outdoors because their bodies can experience rapid heat loss, resulting in hypothermia (abnormally low body temperature). Statistical information regarding hypothermia mortality is provided later in this section.

An indirect winter hazard that affects Missourians every year is carbon monoxide poisoning. Improperly vented gas and kerosene heaters or the indoor use of charcoal briquettes creates dangerous levels of carbon monoxide. There were 204 reported carbon monoxide poisoning cases in 2001–2004. Of the 129 (63.2 percent) that resulted in death, 56 (43.4 percent) were deemed accidental. Accidental carbon monoxide poisonings and deaths are more likely to occur in the colder weather months of the year. In this time period, 27 (21.3 percent) poisonings occurred in January.

Table 3.31 lists the severe winter weather events that have received presidential declarations. The summaries that follow it describe some of the more significant severe winter weather events occurring in Missouri in recent years. (Much of this information was taken from the National Weather Service's *Storm Data and Unusual Weather Phenomena* publication.)

Table 3.31. Presidential Declarations for Missouri Severe Winter Weather Since 1975

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
March 12, 1979	EM 3071	Ice Jam, Flooding	n/a	PA
February 6, 2002	DR 1403	Ice Storm	Adair, Audrain, Barton, Bates, Benton, Boone, Buchanan, Caldwell, Carroll, Cass, Cedar, Chariton, Clark, Clay, Clinton, Cooper, Daviess, DeKalb, Grundy, Henry, Howard, Jackson, Johnson, Knox, Lafayette, Lewis, Linn, Livingston, Macon, Marion, Monroe, Morgan, Pettis, Platte, Ralls, Randolph, Ray, Saline, Scotland, Shelby, St. Clair, Sullivan, Vernon	IA
			Bates, Carroll, Cass, Cedar, Chariton, Clay, Clinton, Henry, Howard, Jackson, Johnson, Knox, Lafayette, Lewis, Linn, Macon, Marion, Monroe, Pettis, Platte, Randolph, Ray, Saline, Shelby, St. Clair, Vernon	PA
December 29, 2006	DR 1673	Severe Winter Storms	Boone, Callaway, Camden, Cole, Greene, Iron, Marion, Miller, Reynolds, St. Francois, St. Louis, Ste. Genevieve, Washington, St. Louis City	PA
January 15, 2007	DR 1676	Severe Winter Storms and Flooding	Barry, Barton, Benton, Boone, Callaway, Camden, Cedar, Christian, Cole, Crawford, Dade, Dallas, Dent, Franklin, Gasconade, Greene, Hickory, Jasper, Laclede, Lawrence, Lincoln, Maries, McDonald, Miller, Montgomery, Newton, Osage, Phelps, Polk, Pulaski, St. Charles, St. Clair, St. Louis, Stone, Texas, Warren, Webster, Wright Counties, St. Louis City	PA

Source: Federal Emergency Management Agency, State Emergency Management Agency
Note:
*IA denotes Individual Assistance; PA denotes Public Assistance

February 15–16, 1993—Central and southern Missouri was covered with up to 21 inches of snow. The airport at Cape Girardeau received 6 inches of snow in one hour and 20 minutes.

January 14–20, 1994—Northeast, central, and east-central Missouri experienced overnight low temperatures from below zero to –20°F. Hundreds of homes and businesses had frozen and

busted water pipes. Wind chills, which ranged from -30 to -50°F, kept schools closed and accounted for 15 people being admitted to local hospitals for hypothermia and frostbite.

January 16–17, 1994—A layer of ice up to 2 inches thick formed over sections of southeast Missouri, followed by 6 to 10 inches of snow. Some areas were without power for more than 24 hours. Roofs collapsed due to the heavy weight of snow and ice.

December 6, 1994—Ice accumulations of 0.5 to 1 inch were reported across northwest, north-central, and northeast Missouri. Over 75 percent of the residents in this region were without power. Phone and cable television were also out. A few rural areas were without power for at least seven days. The city of St. Joseph was declared a disaster area by Governor Mel Carnahan because of damage totaling nearly $4 million.

January 18–19, 1995—Central Missouri received heavy snows, dumping 19.7 inches over Columbia alone and setting a new 24-hour snowfall record. Parts of I-70, I-44, and other major highways were closed due to drifting snow. Snow fell at such a fast rate that snowplows and graders became stuck. Almost 5,000 birds were killed when several large chicken and turkey barns collapsed. Thousands of people were without power and telephone service. The Jefferson City and Columbia airports were closed for a time. The University of Missouri at Columbia canceled classes for the first time in nearly 17 years. State offices in Jefferson City were also closed.

October 22–23, 1996—An early snowfall hit the Kansas City area, dumping as much as 8.5 inches of heavy wet snow. Approximately 130,000 residences were without power, and an estimated $1.5 million in property damage was reported.

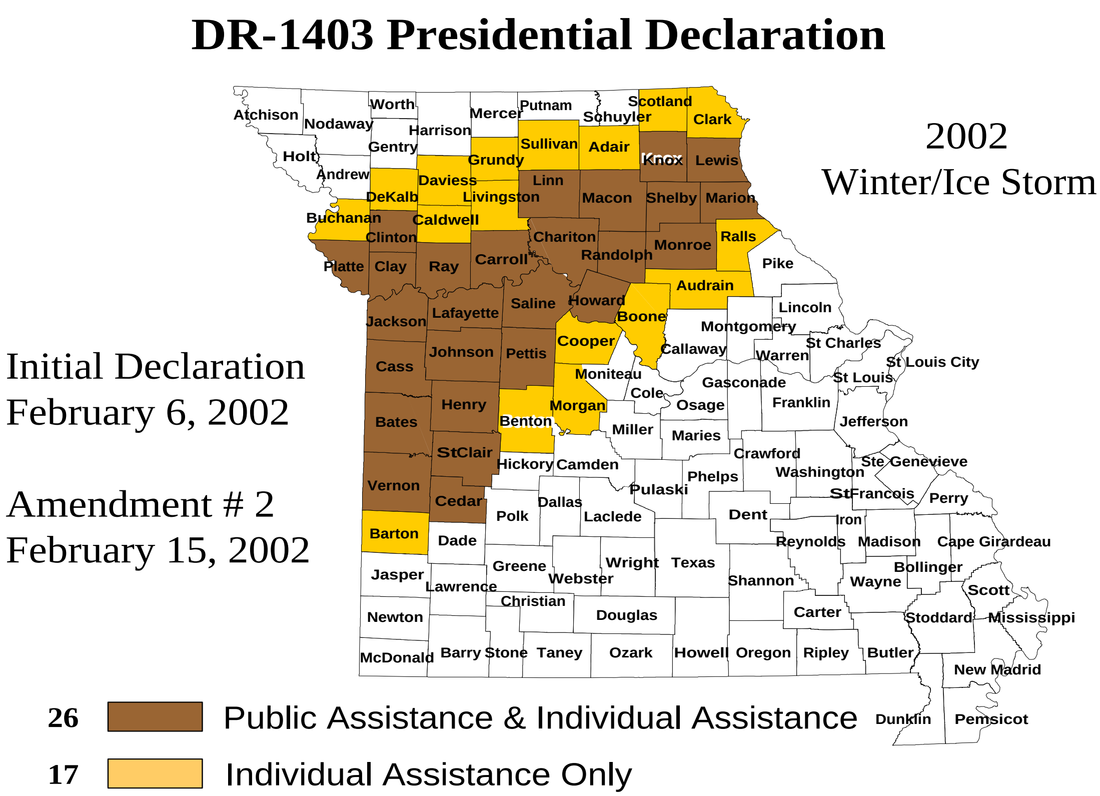
January 10–13, 1997—Northwest and west-central Missouri experienced overnight low temperatures below zero. No record low temperatures were recorded, but winds gusting up to 30 miles per hour produced afternoon wind chills as low as -30 to -50°F.

April 10–11, 1997—A spring snowstorm dumped up to 24 inches in extreme north Missouri. Schuyler County alone reported $2 million in damage, mostly due to the heavy snow causing roofs on farm buildings to collapse.

January 31, 2002 (DR 1403)—A massive severe winter storm system dumped snow and ice from Oklahoma to Kansas and into central and northern Missouri. In Missouri alone, more than 600,000 residents were without power, as ice-encased power lines snapped in fierce winds or were pulled down by falling trees and limbs. Loss of electricity included more than 460,000 people in the Kansas City metro area alone (Jackson, Cass, Clay, and Platte counties). Additionally, residents in a line from Kansas City to the Iowa-Illinois border were without power as rural electric cooperative lines broke as well. Outages ranged from several days to nearly two weeks. Damage to property, power restoration, and the cost of debris removal for local governments was so high that Missouri received a presidential disaster declaration (DR 1403) on February 6, 2002, which ultimately included 43 counties; 26 were designated for both Individual

and Public Assistance, and 17 were eligible for Individual Assistance only (see Figure 3.44). The total eligible Public Assistance costs for this disaster ($61.9 million dollars as of August 2002) ranks the 2002 ice storm as Missouri’s second most costly disaster to date.

Figure 3.44. January 2002 Ice Storm



November 30–December 1, 2006 (DR 1673)—A severe winter storm dropped freezing rain, sleet, ice, and snow over Missouri (see Figure 3.45 for a map of the counties that received disaster declarations). According to Pat Guinan, University of Missouri climatologist, the storm was unprecedented for the time of year it hit. Some areas of the state experienced up to 14 inches of snow. The freezing rain and sleet caused major power outages, blocked roads, and caused structural damage to buildings across the state. Eleven deaths were attributed to the event.

January 12–14, 2007 (DR 1676)—A series of severe winter storms swept across Missouri causing heavy damage throughout the state. An area from Joplin to St. Louis along the I-44 corridor was the heaviest hit (see Figure 3.46 for a map of the counties that received disaster declarations). The storm system caused power outages for over 330,000 households/businesses statewide, caused 15 weather-related deaths, and sent over 4,300 citizens to more than 119 shelters. Preliminary eligible costs for Public Assistance were estimated at $109.3 million.

Figure 3.45. November–December 2006 Winter Storm

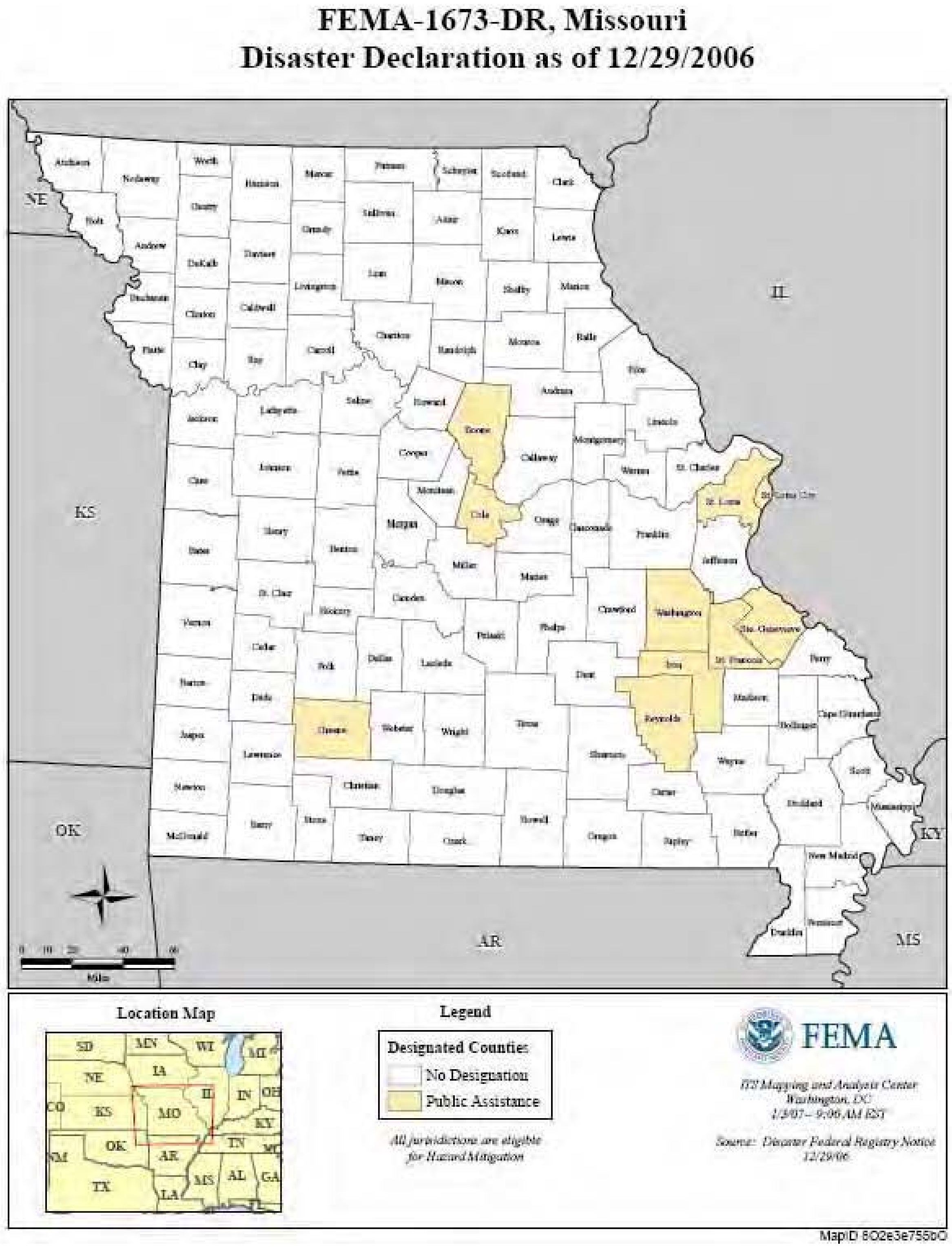
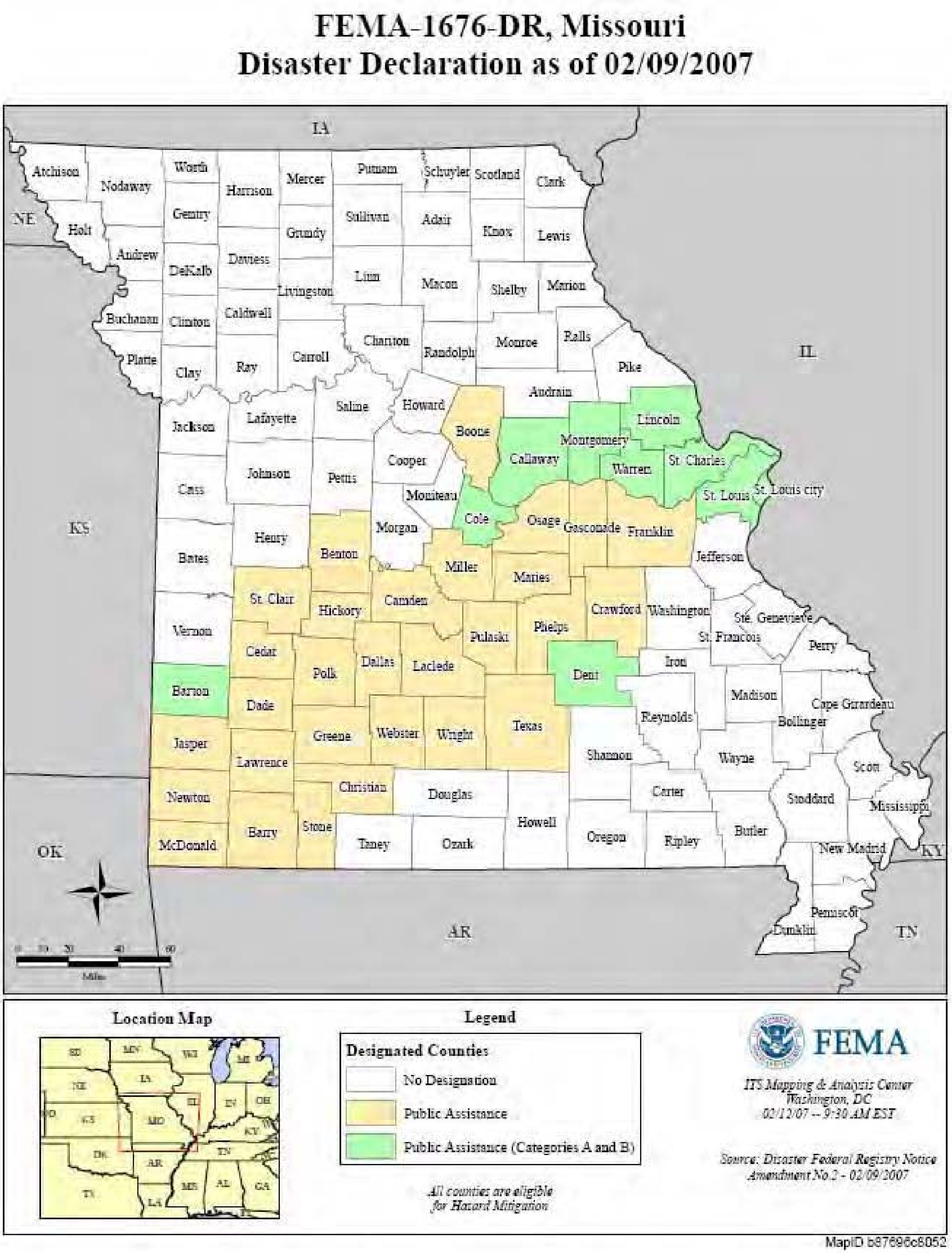


Figure 3.46. January 2007 Winter Storms



Measure of Probability and Severity

North of Missouri River

Probability: High
Severity: Moderate

South of Missouri River

Probability: Moderate
Severity: Moderate

It is quite difficult to make an objective and quantitative measure of the probability and severity of snowstorms, ice storms, and extreme cold. Therefore, any analysis should be considered subjective and qualitative.

For areas north of the Missouri River, the probability of a snowstorm, ice storm, or extreme cold should be considered high due to historically higher average snowfall and lower average temperatures. However, the severity is rated moderate due to the overall level of preparedness in this area. For example, homes and businesses may be better insulated due to the higher probability of severe cold relative to other areas. Also, people living in this area may be more likely to use snow tires or purchase four-wheel-drive vehicles. People living in this area may be more likely to maintain adequate supplies of home heating fuels and consider other preparedness measures. Local and state governments may have access to more snow clearing equipment and maintain adequate supplies of materials needed for snow or ice removal. School districts and businesses may be more likely to develop and use snow routes or establish closing procedures.

Areas south of the Missouri River have a moderate probability of a snowstorm, ice storm, or extreme cold due to their lower average snowfalls and temperatures. Events in these areas also have a moderate potential severity. This may be due to a lower level of preparedness. People living in this area may have homes with inadequate insulation or fail to maintain an adequate supply of home heating fuels. People may be less likely to equip their vehicles with snow tires or purchase four-wheel-drive vehicles. Local and state governments may not maintain sufficient amounts of equipment and materials. Schools and businesses may not have formal snow routes or closing procedures.

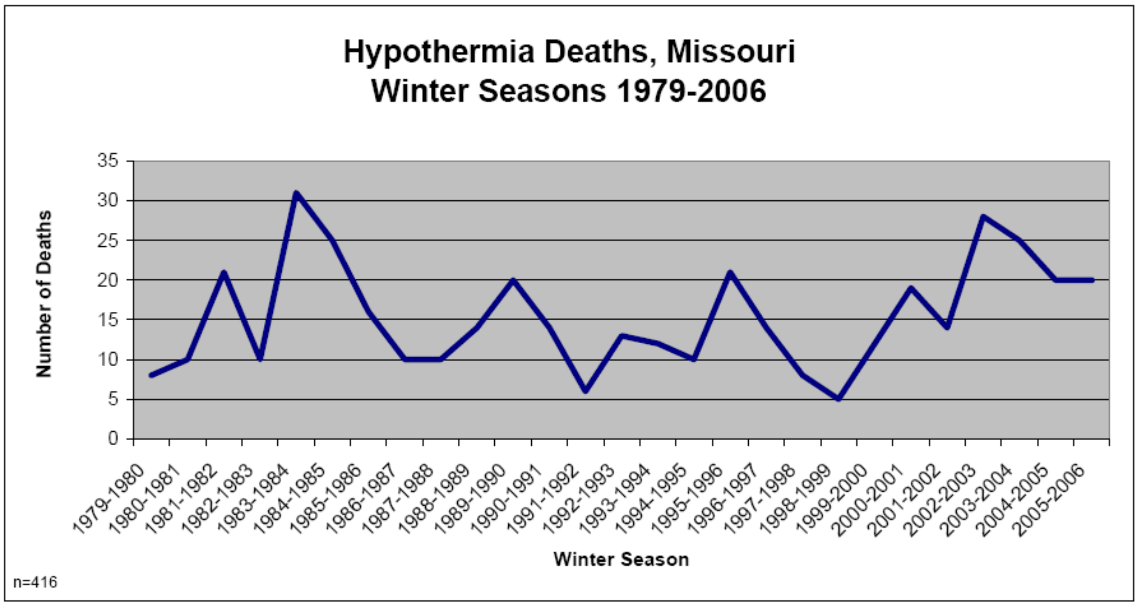
Impact of the Hazard

People are adversely affected by winter storms, ice storms, and extreme cold, some more than others. Observations by the National Oceanic and Atmospheric Administration (NOAA) indicate that of winter deaths related to exposure to cold, 50 percent were over 60 years old, over 75 percent were male, and about 20 percent occurred in the home. Of winter deaths related to ice and snow, about 70 percent occur in automobiles, and 25 percent are people caught in storms. As noted earlier, ice storms can result in significant economic costs to homeowners, business

owners, and utility companies. The ice storm in December 1994 demonstrated the environmental damage that can occur. Thousands of trees and plants were cut down or damaged as a result of the ice storm. The problem of debris clearance caused environmental impacts due to the permitted burning of debris and reduced landfill space.

Hypothermia: Hypothermia is defined as a cold injury associated with a fall of body temperature to less than 94.1ºF, which results from unintentional exposure to a cold environment. Data from the Missouri Department of Health and Senior Services shows that, in Missouri, 416 people have died from the cold during the winter months between 1979 and 2006 (data collection of hypothermia first began in Missouri in 1979) (see Figure 3.47). There were 28 deaths during the 2002–2003 cold weather season and 20 deaths during the 2003–2004 season.

Figure 3.47. Hypothermia Deaths, Missouri: Winter Seasons 1979–2006

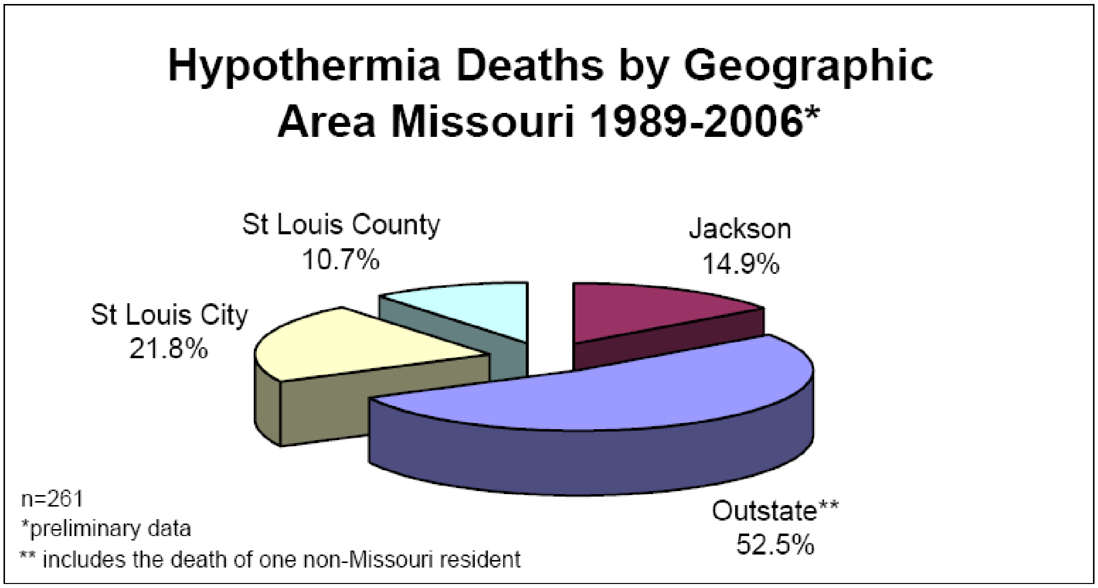


Source: Missouri Department of Health and Senior Services

The elderly are more likely to be victims of cold-related illness resulting in death. Too often, handicapped or elderly individuals fall outside their homes and are unable to reach shelter or help. During the cold weather seasons 1989–2006, 130 (49.8 percent) hypothermia deaths were of people aged 65 years and older. Deaths of individuals between the ages of 25 and 64 often have a contributing cause of substance abuse or a debilitating medical condition. Since 1989, there have been 124 (47.5 percent) hypothermia deaths in this population. Fortunately, deaths in people age <25 years are rare, accounting for only 7 (2.7 percent) of the total 261 Missouri hypothermia deaths during this time frame. From cold weather winter seasons 2000 through 2006, the largest number of deaths were among white males, making up 52.5 percent (n=137) of the 261 total cold-related deaths.

In Missouri, slightly more deaths have occurred in the more rural areas of the state than in the metropolitan areas. Jackson County had 39 (14.9 percent) deaths, St. Louis County had 28 (10.7 percent), and St. Louis City had 57 (21.8 percent) of the total 261 hypothermia deaths since 1989 (see Figure 3.48).

Figure 3.48. Hypothermia Deaths by Geographic Area, Missouri: 1989–2006



Source: Missouri Department of Health and Senior Services

The information in Table 3.32 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.32. EMAP Impact Analysis: Severe Winter Weather

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be severe for affected areas and moderate to light for other less affected areas.
Health and Safety of Personnel Responding to the Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for trained, equipped, and protected personnel.
Continuity of Operations	Unlikely to necessitate execution of the Continuity of Operations Plan.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the areas of the incident. Power lines and roads most adversely affected.
Delivery of Services	Localized disruption of roads and/or utilities caused by incident may postpone delivery of some services.
The Environment	Environmental damage to trees, bushes, etc.
Economic and Financial Condition	Local economy and finances may be adversely affected, depending on damage.
Regulatory and Contractual Obligations	Regulatory waivers may be needed locally. Fulfillment of some contracts may be difficult. Impact may temporarily reduce deliveries.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

As noted in this report, snowstorms, ice storms, and extreme cold can interact to cause many hazards. Only a few degrees may be the difference between rain, ice, or snow. Duration and intensity of any of these events will determine the overall impact of a particular event. Wind speed may be the difference between a minor snow and a blizzard. These events cannot be prevented. Preparedness for these events may be the greatest single factor to reduce loss of life, injury, and property damage. NOAA weather broadcasts via radio and television provide important information for people to prepare and thus reduce risks to their lives and property.

3.2.9 Tornadoes/Severe Thunderstorms

Description of Hazard

Tornadoes are cyclical windstorms often associated with the Midwestern areas of the United States. Weather conditions conducive to tornadoes often produce a wide range of other

dangerous storm activities, including severe thunderstorms, downbursts, straight-line winds, lightning, hail, and heavy rains. For the purpose of this analysis, tornadoes are considered in one category. Other severe weather activities, noted above, are referenced separately in the synopsis of this section.

Essentially, tornadoes are a vortex storm with two components of winds. The first is the rotational winds that can measure up to 500 miles per hour, and the second is an uplifting current of great strength. The dynamic strength of both these currents can cause vacuums that can overpressure structures from the inside.

Although tornadoes have been documented in all 50 states, most of them occur in the central United States. The unique geography of the central United States allows for the development of thunderstorms that spawn tornadoes. The jet stream, which is a high-velocity stream of air, determines which area of the central United States will be prone to tornado development. The jet stream normally separates the cold air of the north from the warm air of the south. During the winter, the jet stream flows west to east from Texas to the Carolina coast. As the sun “moves” north, so does the jet stream, which at summer solstice flows from Canada across Lake Superior to Maine. During its move northward in the spring and its recession south during the fall, the jet stream crosses Missouri, causing the large thunderstorms that breed tornadoes.

Tornadoes spawn from the largest thunderstorms. The associated cumulonimbus clouds can reach heights of up to 55,000 feet above ground level and are commonly formed when Gulf air is warmed by solar heating. The moist, warm air is overridden by the dry cool air provided by the jet stream. This cold air presses down on the warm air, preventing it from rising, but only temporarily. Soon, the warm air forces its way through the cool air, and the cool air moves downward past the rising warm air. This air movement, along with the deflection of the earth’s surface, can cause the air masses to start rotating. This rotational movement around the location of the breakthrough forms a vortex, or funnel. If the newly created funnel stays in the sky, it is referred to as a funnel cloud. However, if it touches the ground, the funnel officially becomes a tornado.

A typical tornado can be described as a funnel-shaped cloud that is “anchored” to a cloud, usually a cumulonimbus that is also in contact with the earth’s surface. This contact on average lasts 30 minutes and covers an average distance of 15 miles. The width of the tornado (and its path of destruction) is usually about 300 yards. However, tornadoes can stay on the ground for upward of 300 miles and can be up to a mile wide. The National Weather Service, in reviewing tornadoes occurring in Missouri between 1950 and 1996, calculated the mean path length at 2.27 miles and the mean path area at 0.14 square mile.

The average forward speed of a tornado is 30 miles per hour but may vary from nearly stationary to 70 miles per hour. The average tornado moves from southwest to northeast, but tornadoes have been known to move in any direction. Tornadoes are most likely to occur in the afternoon and evening, but have been known to occur at alls hours of the day and night.

Tornadoes are classified according to the F-Scale (developed by Dr. Theodore Fujita, a renowned severe storm researcher). The F-Scale attempts to rank tornadoes according to wind speed based on the damage caused (see Table 3.33). Table 3.34 lists Missouri Tornadoes by F-Scale, 1950–1996.

Table 3.33. Fujita Tornado Damage Scale

Scale	Wind Speed (mph)*	Typical Damage
F0	<73	Light damage: Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; signboards damaged
F1	73-112	Moderate damage: Surface peeled off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads
F2	113-157	Considerable damage: Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground
F3	158-206	Severe damage: Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forests uprooted; heavy cars lifted off ground and thrown some distance
F4	207-260	Devastating damage: Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown; large missiles generated
F5	261-318	Incredible damage: Strong frame houses leveled off foundations and swept away; automobile-sized missiles propelled through the air more than 100 meters (109 yards); trees debarked; incredible phenomena will occur

Source: Developed in 1971 by T. Theodore Fujita of the University of Chicago, National Weather Service, 2003
Note:
*Do not use F-scale wind speeds literally. These wind speed numbers are actually estimates and have never been scientifically verified. Different wind speeds may cause similar damage from place to place—even from building to building. Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.

Table 3.34. Missouri Tornadoes by F-Scale, 1950–1996

Scale	Percentage
F0	47
F1	24
F2	16
F3	12
F4	1
F5	0

Tornadoes are usually associated with severe thunderstorms, which, by themselves, possess destructive potential. Such storms most often occur in the spring and summer during the afternoon and evening hours but can occur at any time. In addition to tornadoes, other hazards

associated with thunderstorms include damaging winds, lightning and resulting fires, hail, and heavy rains causing flash flooding.

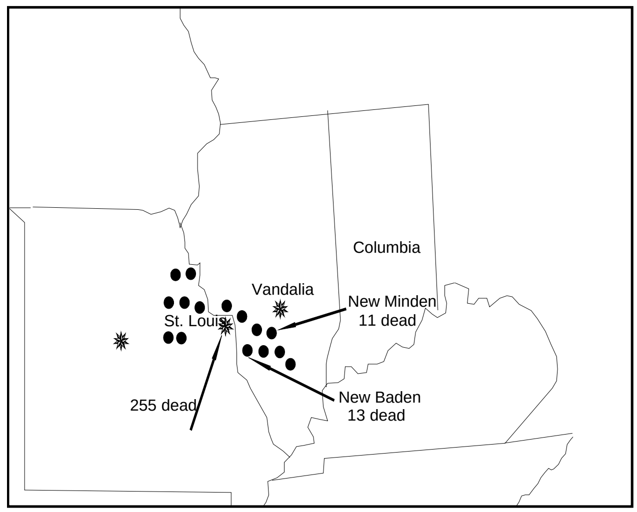
The damaging winds of thunderstorms include downbursts, microbursts, and straight-line winds. Downbursts are localized currents of air blasting down from a thunderstorm, which induce an outward burst of damaging wind on or near the ground. Microbursts are minimized downbursts covering an area of less than 2.5 miles across. They include a strong wind shear (a rapid change in the direction of wind over a short distance) near the surface. Microbursts may or may not include precipitation and can produce winds at speeds of more than 150 miles per hour.

Damaging straight-line winds are high winds across a wide area that can reach speeds of 140 miles per hour. Large hail can reach the size of grapefruit. Hail causes several hundred millions of dollars in damage annually to property and crops across the nation. In addition, lightning kills 75 to 100 people each year.

Historical Statistics

Historically, the Missouri has experienced numerous tornadoes of varied intensities. On May 27, 1896, between the hours of 2 and 8 p.m., a series of 18 tornadoes known as the "St. Louis, Missouri, Outbreak" struck Missouri and Illinois. These tornadoes resulted in 306 deaths and $15 million in damage (see Figure 3.49).

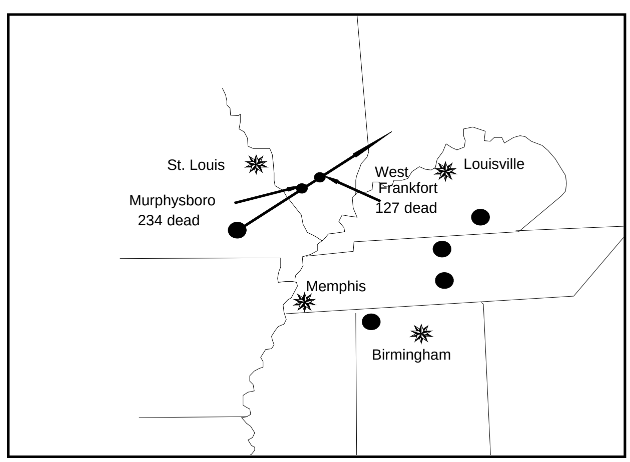
Figure 3.49. St. Louis, Missouri, Tornado Outbreak of 1896



The National Weather Service reports that 1,584 tornadoes occurred in Missouri from 1950 to 2005, with 187 deaths and over $900 million in damage. This averages 28 tornadoes per year and 3 deaths per year.

The worst tornado in U.S. history, in terms of deaths and destruction, occurred in Missouri on March 18, 1925, between 1 and 6 p.m. (see Figure 3.50). The great "tri-state" tornado originated in Reynolds County. It proceeded east-northeast through the southern quarter of Illinois and into Indiana, covering 219 miles. It caused over $18 million in damage, affected six states, and killed 689 people.

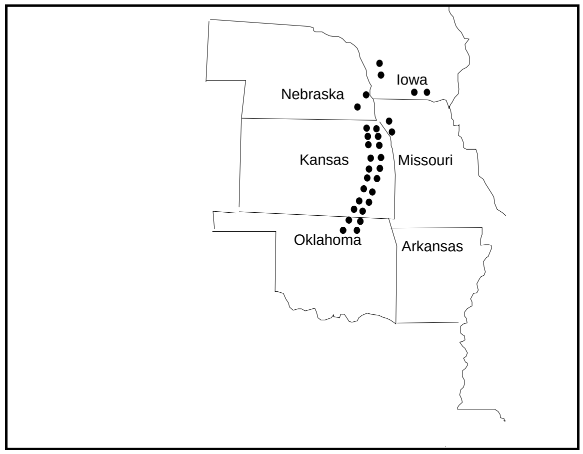
Figure 3.50. The Great Tri-State Tornado of 1925



The City of Poplar Bluff, Missouri, was almost wiped out by a tornado on May 9, 1927. This tornado cost 92 lives and $2 million in damage. The same day, two severe tornadoes struck St. Louis, Missouri. The first

tornado moved across the entire city from the western city limits to the Mississippi River through the Lafayette Park area, killing 306 people in Missouri and Illinois and causing almost $13 million in damage. The second tornado started in the southwestern part of the city and proceeded through the Tower Grove and Vanderventer areas, then on to Granite City, Illinois. Seventy-nine people were killed, and about $23 million in damage resulted from this storm.

Figure 3.51. The Tornado Super Outbreak in 1974



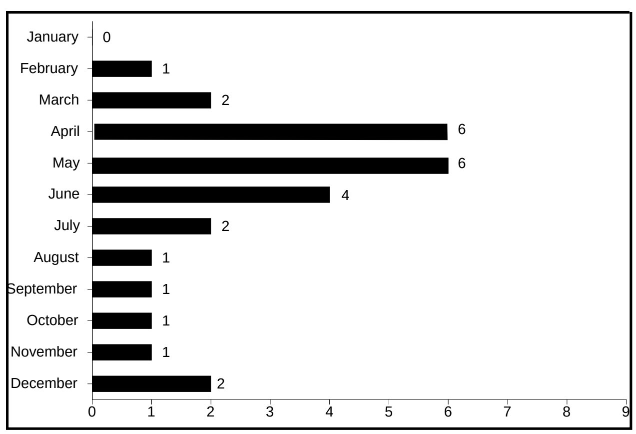
During the afternoon and evening of April 3, and the early morning of April 4, 1974, a "super outbreak" of 148 tornadoes across 13 states killed more than 300 people, injured more than 6,000 and caused $600 million in damage (see Figure 3.51).

On the afternoon of April 26, and the early morning of April 27, 1991, an outbreak of 54 tornadoes covering six states, including Missouri, resulted in 21 deaths, 308 injuries, and damage exceeding $277 million. There were two deaths in vehicles and 15 deaths in and near mobile homes.

On July 4, 1995, at approximately 5:40 p.m., a tornado struck the Randolph County community of Moberly. The initial touchdown of the storm was south of town. The storm then moved through the eastern half of the community. The tornado uplifted approximately 7 miles northeast of Moberly. At least 15 people were injured, 25 businesses damaged, along with the courthouse, and some 300 families affected. This resulted in a Small Business Administration disaster declaration for low interest loans. The tornado was characterized by the National Weather Service as an F3 tornado.

Figure 3.52 shows that tornadoes in Missouri occur most frequently between April and June, with April and May usually producing the most tornadoes. However, tornadoes can occur any time of the year, such as the storms that struck in St. Charles and Barry counties in November 1988.

Figure 3.52. Missouri Tornadoes, Average per Month, 1950–1996



A record 84 tornadoes were recorded in Missouri in 2003. During the week of May 4, 2003, 79 of those tornadoes occurred and mostly in the southwest portion of Missouri. There were several F4 tornadoes on May 4 in

Platt, Clay, and Barton counties. There were nineteen people killed by the tornadoes in southwest Missouri. That is the highest total since 1959 when 21 were killed. It is only the fourth year in which double-digit deaths from tornadoes occurred in Missouri since 1950. The killer tornadoes all occurred on May 4, 2003 (see Figures 3.53 and 3.54). The tornadoes that hit Newton, Lawrence, Christian, and Greene counties killed seven people. Five people were killed by a tornado that hit Cedar and Dallas counties. A tornado that hit Camden County killed four people, two people died from a tornado in Jasper County, and one person died in Barton County. The tornadoes injured 171 people. That is the highest total since 1957 when 310 people were injured. This information was provided by the National Weather Service.

Figure 3.53. Map of the May 4, 2003, Tornadoes

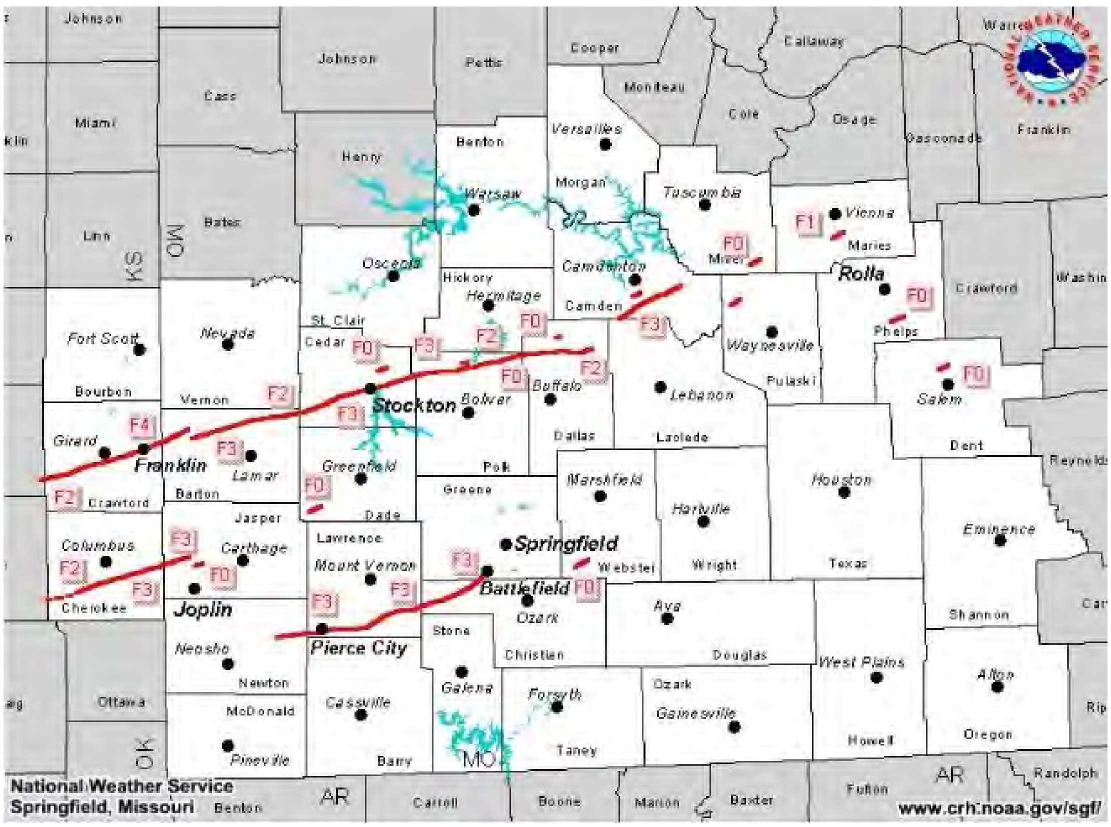
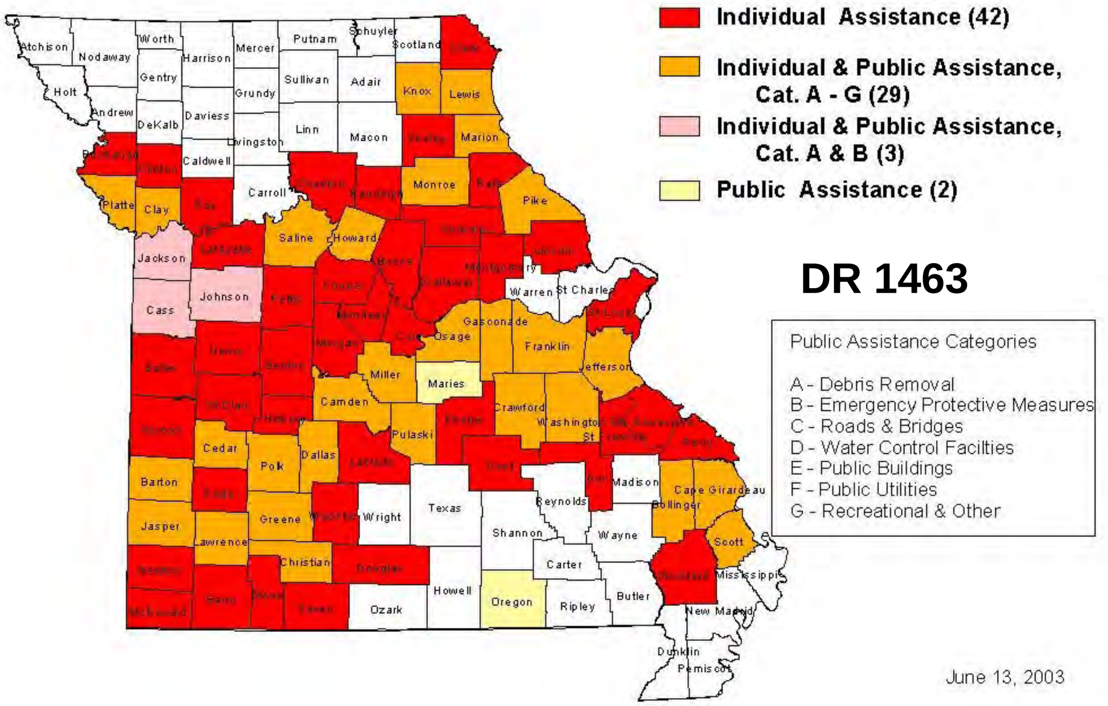
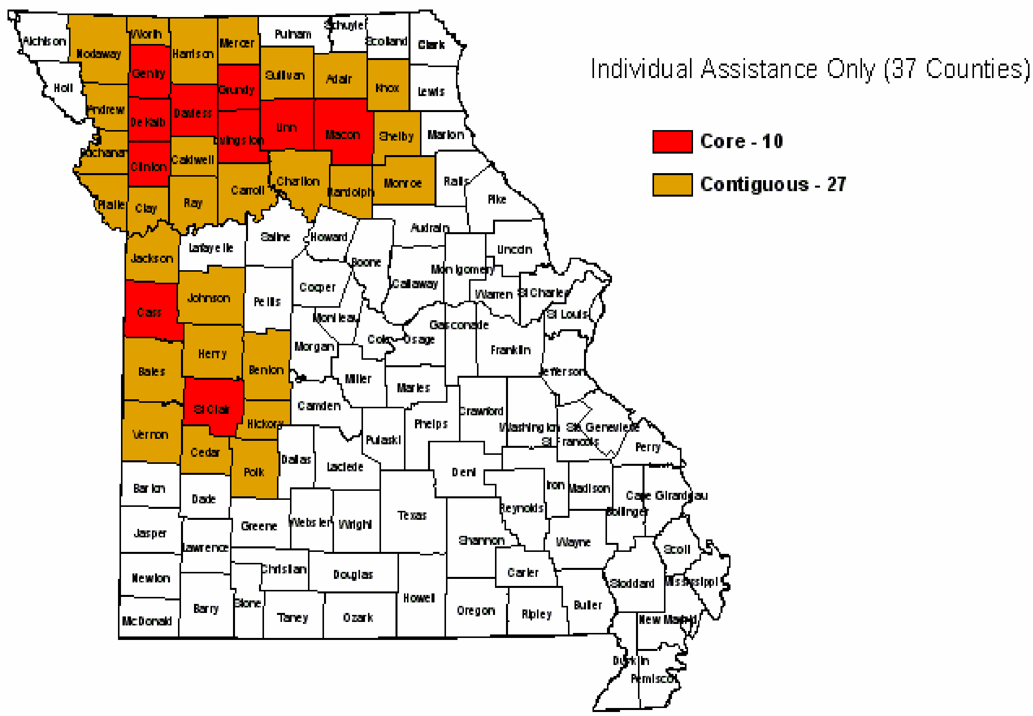


Figure 3.54. Disaster Assistance by County, May 2003



On May 29, 2004, nine tornadoes touched down in northern and western Missouri (See Figure 3.55). The strongest, an F4, struck just east of Weatherby destroying homes and killing three people.

Figure 3.55. Disaster Assistance by County, May 29, 2004



The year 2006 was a record year for tornadoes and severe weather outbreaks for Missouri. Four sets of major storms went through the state: March 8–13 (DR 1631), March 30–April 2 (DR 1635), July 19–21 (EM 3267 and DR 1667), and September 22–23 (currently in the appeal process for declaration).

Between the two March/April storms, which both received declarations for severe storms, tornadoes, and flooding, 44 tornadoes touched down in Missouri. Fourteen people were killed (making it the fifth year in which double-digit deaths from tornadoes occurred in Missouri since 1950), 147 were injured, 646 homes were destroyed, 3,678 homes were damaged, and 1,134 homes were affected. As of June 14, 2006, Missouri citizens had received more than $32 million in federal recovery assistance. As a result of the first round of storms, 41 counties received major disaster declarations (see Figure 3.56). The second round of storms resulted in major disaster declarations for seven counties (see Figure 3.57). In Pemiscot County, 100 percent of Braggadocio, 80 percent of Deering, and over 60 percent of Caruthersville were destroyed. Major problems included drinking water, utilities, debris removal, and shelter and housing.

Figure 3.56. Disaster Assistance by County—March 2006

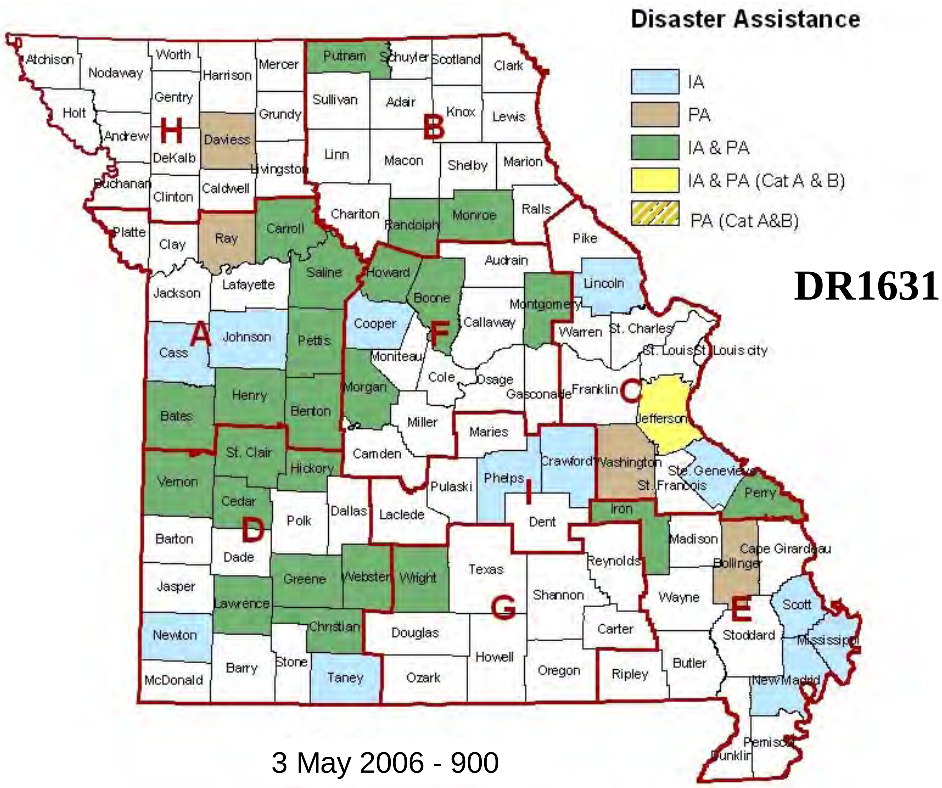
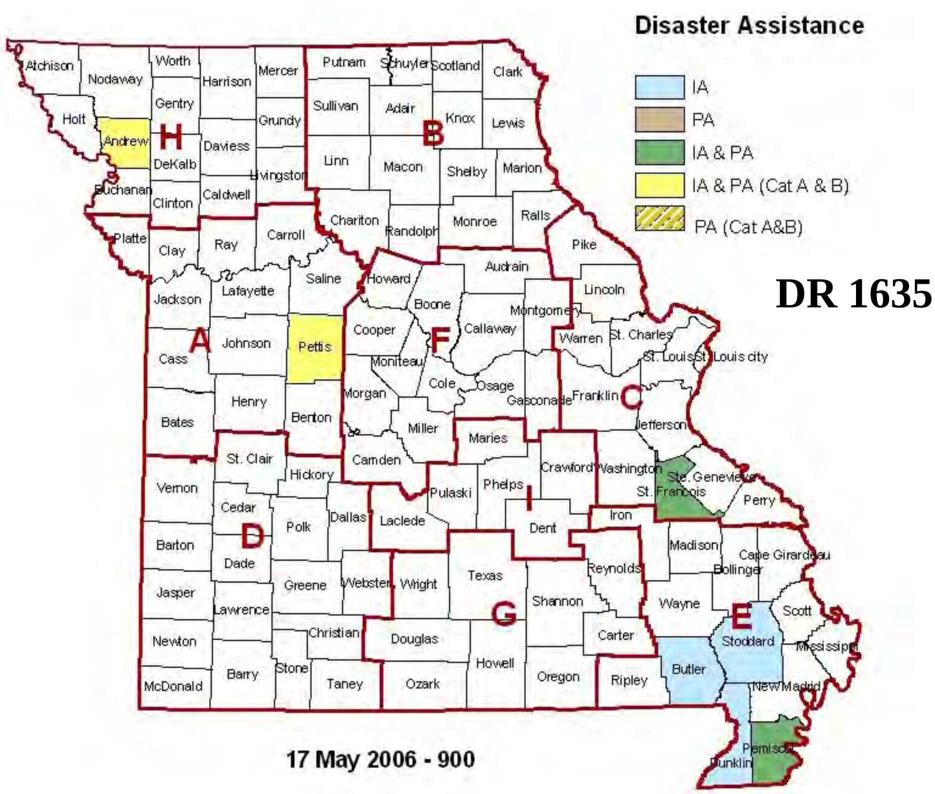


Figure 3.57. Disaster Assistance by County—April 2006



Seven counties and St. Louis City received emergency declarations for July's severe storms (see Figure 3.58). In November, St. Louis City was granted a major disaster declaration. Three deaths were attributed to this set of storms. In September, a series of severe storms and tornadoes swept across the state and destroyed over 600 residences and 75 businesses in 12 counties (see Figure 3.59). The National Weather Service confirmed an F4 tornado in Perry County.

Figure 3.58. Disaster Assistance by County—July 2006

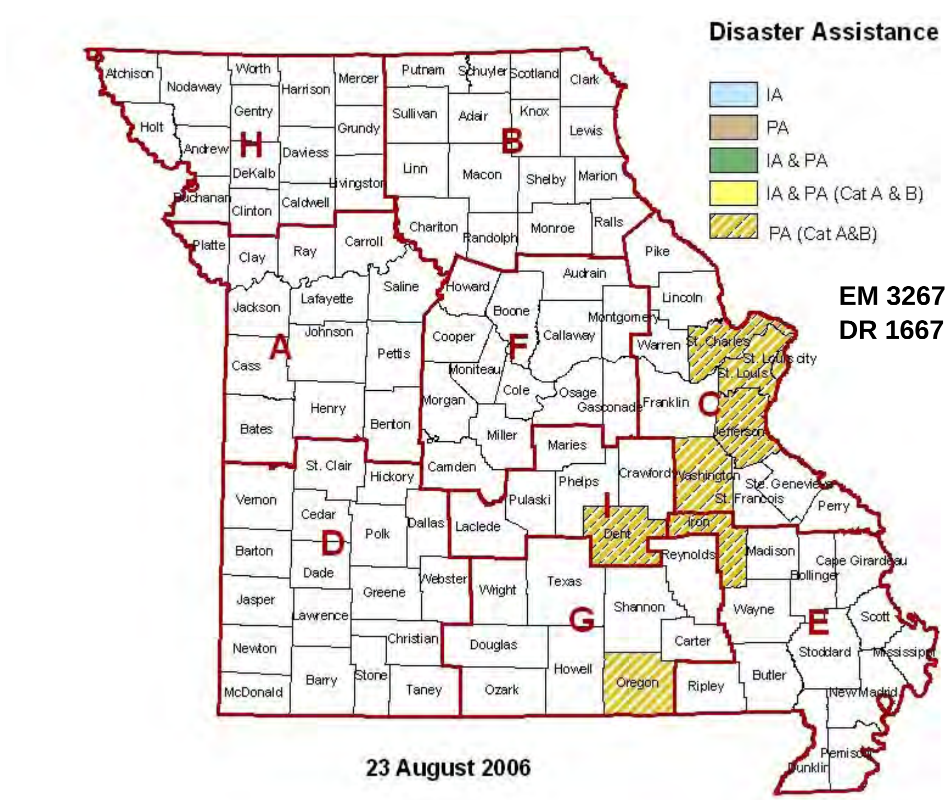


Figure 3.59. Damage Assessment Status by County—September 2006

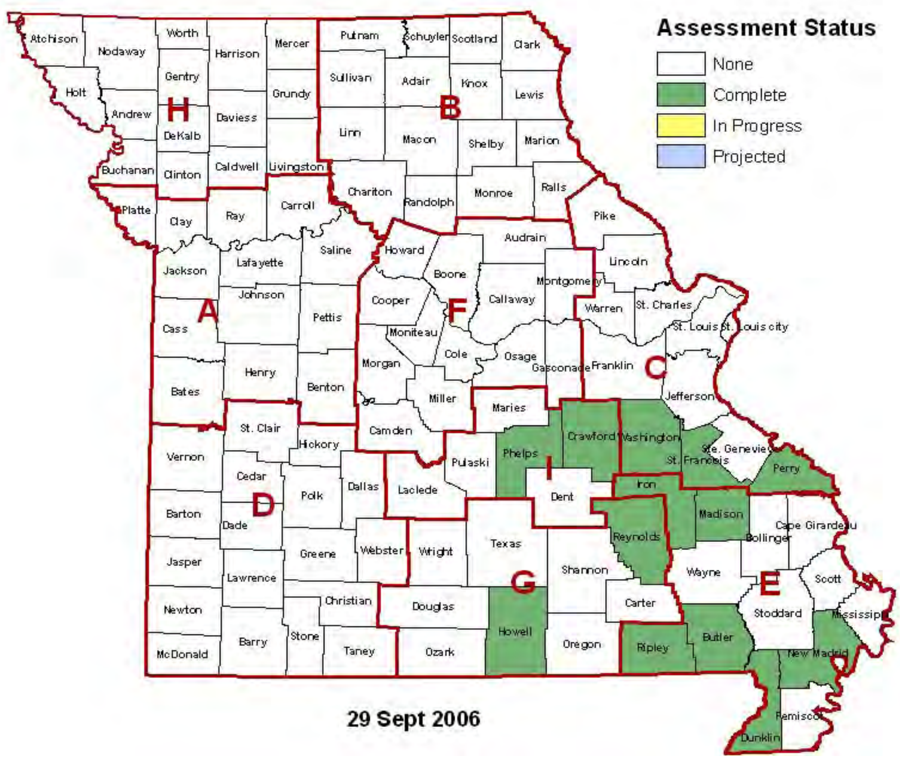


Table 3.35 lists Missouri tornado events that resulted in federal disaster declarations since 1975. Table 3.36 summarizes Missouri tornado statistics from 1950 through 2005. Figures 3.60 through 3.63 illustrate Missouri tornadoes and tornado deaths by county.

Table 3.35. Disaster Declarations for Missouri Tornado Events Since 1975

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
May 3, 1975	DR 466	Tornadoes, High Winds, Hail	Caldwell, Newton, Macon, Shelby	PA & IA
May 7, 1977	DR 535	Tornadoes, Flooding	Carroll, Clay, Lafayette, Ray, Cass, Jackson, Pettis	PA & IA
April 21, 1979	DR 579	Tornadoes, Torrential Rain, Flooding	n/a	
May 15, 1980	DR 620	Severe Storms, Tornadoes	Pettis	IA Only
May 1986	n/a	Tornadoes	Scott, Mississippi, Cape Girardeau, Perry	SBA Loans
November 1988	n/a	Tornadoes	St. Charles, Barry	SBA Loans

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
December 1, 1993	DR 1006	Flooding, Severe Storm, Tornadoes	Bollinger, Butler, Cape Girardeau, Carter, Crawford, Dent, Franklin, Howell, Iron, Jefferson, Madison, Oregon, Perry, Pulaski, Reynolds, Ripley, Shannon, St. Francois, St. Louis, Ste. Genevieve, Stoddard, Texas, Washington, Wayne	IA
			Carter, Dent, Howell, Iron, Madison, Oregon, Perry, Reynolds, Shannon, St. Francois, Ste. Genevieve, Texas, Washington, Wayne	PA
April 21, 1994	DR 1023	Severe Storm, Flooding, Tornadoes	Barry, Callaway, Clay, Cole, Franklin, Jefferson, Lincoln, Morgan, Pemiscot, Phelps, Pulaski, Reynolds, Shannon, St. Charles, St. Louis, Vernon, Washington, St. Louis City	IA
June 2, 1995	DR 1054	Severe Storm, Tornadoes, Hail, Flooding	Adair, Andrew, Atchison, Barry, Barton, Bates, Benton, Boone, Callaway, Camden, Cape Girardeau, Carroll, Cass, Chariton, Clark, Cole, Cooper, Dallas, Daviess, DeKalb, Franklin, Gasconade, Gentry, Henry, Howard, Jackson, Jasper, Jefferson, Johnson, Lafayette, Lewis, Lincoln, Linn, Macon, Maries, McDonald, Mercer, Miller, Mississippi, Moniteau, Montgomery, Morgan, New Madrid, Newton, Nodaway, Osage, Pemiscot, Perry, Ray, Saline, Scotland, Scott, St. Charles, St. Clair, St. Francois, St. Louis, Ste. Genevieve, Stone, Sullivan, Vernon, Warren, St. Louis City	IA
			Andrew, Atchison, Barry, Bates, Benton, Boone, Callaway, Cape Girardeau, Carroll, Chariton, Clark, Cole, Cooper, Daviess, DeKalb, Franklin, Gasconade, Gentry, Henry, Howard, Jefferson, Johnson, Lafayette, Linn, Macon, McDonald, Mercer, Miller, Mississippi, Moniteau, Montgomery, Nodaway, Perry, Ray, Saline, St. Charles, St. Clair, St. Louis, Ste. Genevieve, Stone, Sullivan, Vernon, Warren	PA
July 1995	n/a	Tornadoes	Randolph, (City of Moberly)	SBA Loans

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
May 6, 2002	DR 1412	Severe Storms and Tornadoes	Barry, Barton, Bollinger, Butler, Camden, Cape Girardeau, Carter, Cedar, Christian, Crawford, Dade, Dallas, Dent, Douglas, Dunklin, Greene, Hickory, Howell, Iron, Jasper, Jefferson, Laclede, Lawrence, Madison, McDonald, Mississippi, New Madrid, Newton, Oregon, Ozark, Pemiscot, Perry, Polk, Reynolds, Ripley, Scott, Shannon, St. Francois, St. Genevieve, Stoddard, Stone, Taney, Texas, Vernon, Washington, Wayne, Webster, Wright	IA
			Adair, Barry, Barton, Bollinger, Boone, Butler, Camden, Cape Girardeau, Carroll, Carter, Cedar, Chariton, Christian, Clark, Cooper, Crawford, Dade, Dallas, DeKalb, Dent, Douglas, Grundy, Howard, Howell, Iron, Johnson, Knox, Laclede, Lafayette, Lawrence, Lewis, Lincoln, Linn, Livingston, Macon, Madison, Maries, Marion, McDonald, Mercer, Miller, Mississippi, Oregon, Osage, Ozark, Pemiscot, Perry, Phelps, Pike, Polk, Pulaski, Ralls, Ray, Reynolds, Ripley, Schuyler, Scotland, Scott, Shannon, Shelby, Ste. Genevieve, Stoddard, Stone, Sullivan, Taney, Texas, Vernon, Wayne, Webster, Wright	PA

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
May 6, 2003	DR 1463	Severe Storms, Tornadoes, and Flooding	Barry, Barton, Bates, Benton, Bollinger, Buchanan, Camden, Cape, Cass, Cedar, Christian, Clay, Clinton, Cooper, Crawford, Dade, Dallas, Dent, Douglas, Franklin, Knox, Gasconade, Girardeau, Greene, Henry, Hickory, Iron, Jackson, Jasper, Jefferson, Johnson, Laclede, Lafayette, Lawrence, McDonald, Miller, Monroe, Morgan, Newton, Osage, Perry Pettis, Phelps, Platte, Polk, Pulaski, Ray, St. Francois, St. Louis, Ste. Genevieve, Saline, Scott, St. Clair, Stoddard, Stone, Taney, Vernon, Washington, Webster	IA
			Bollinger, Crawford, Franklin, Gasconade, Knox, Maries, Miller, Oregon, Osage, Pulaski, Washington	PA
June 11, 2004	DR 1524	Severe Storms, Tornadoes, and Flooding	Adair, Andrew, Bates, Benton, Caldwell, Carroll, Cass, Cedar, Chariton, Clay, Clinton, Daviess, DeKalb, Gentry, Grundy, Harrison, Henry, Hickory, Jackson, Johnson, Knox, Linn, Livingston, Macon, Mercer, Monroe, Nodaway, Platte, Polk, Randolph, Ray, Shelby, St. Clair, Sullivan, Vernon, Worth	IA
March 16, 2006	DR 1631	Severe Storms, Tornadoes, and Flooding	Bates, Benton, Boone, Carroll, Cass, Cedar, Christian, Cooper, Crawford, Greene, Henry, Hickory, Howard, Iron, Jefferson, Johnson, Lawrence, Lincoln, Mississippi, Monroe, Montgomery, Morgan, New Madrid, Newton, Perry, Pettis, Phelps, Putnam, Randolph, St. Clair, Ste. Genevieve, Scott, Saline, Taney, Vernon, Webster, Wright	IA
			Bates, Bollinger, Benton, Boone, Carroll, Cedar, Christian, Daviess, Greene, Henry, Hickory, Howard, Iron, Lawrence, Monroe, Montgomery, Morgan, Perry, Pettis, Putnam, Randolph, Ray, Saline, St. Clair, Vernon, Washington, Webster, Wright	PA

Declaration Date	Disaster No.	Incident Type	Counties Declared	Type of Assistance*
April 5, 2006	DR 1635	Severe Storms, Tornadoes, and Flooding	Andrew, Butler, Dunklin, Pemiscot, St. Francois, Stoddard	IA
			Andrew, Jefferson, Pemiscot, Pettis, St. Francois	PA

Source: Federal Emergency Management Agency, State Emergency Management Agency
Note:
*IA denotes Individual Assistance; PA denotes Public Assistance, SBA denotes Small Business Administration

Table 3.36. Missouri Tornado Statistics, 1950–2005

Total Number of Tornadoes	1,584
Total Number of Deaths	187
Total Number of Injuries	2,566
Yearly Average of Tornadoes	28
Yearly Average of Deaths	3
Yearly Average of Injuries	46
Tornado Deaths 1916–2006	774

Figure 3.60. Missouri Tornadoes by County: Top Twenty-Five, 1950–2005

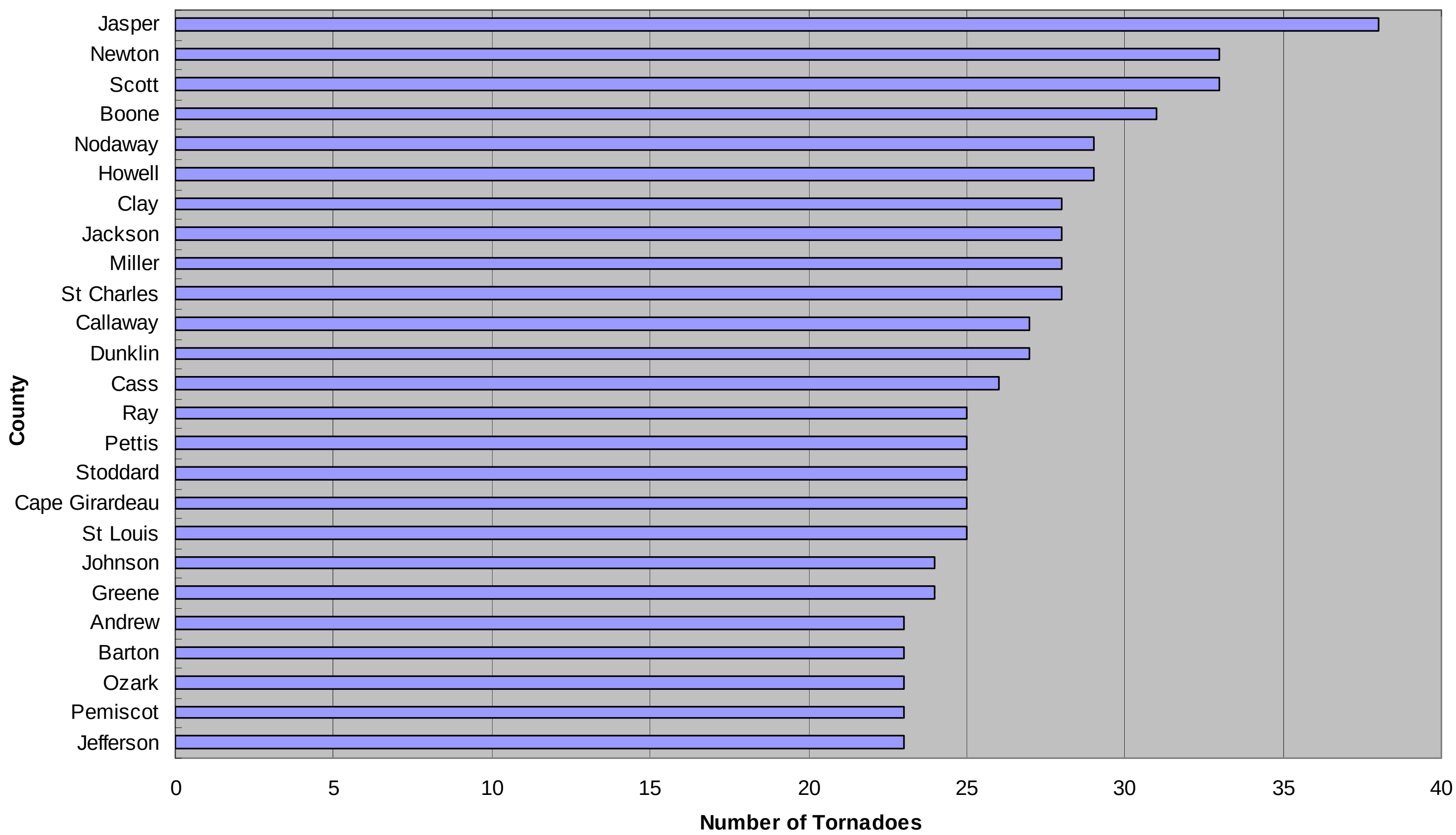


Figure 3.61. Missouri Tornadoes by County, 1950–2006

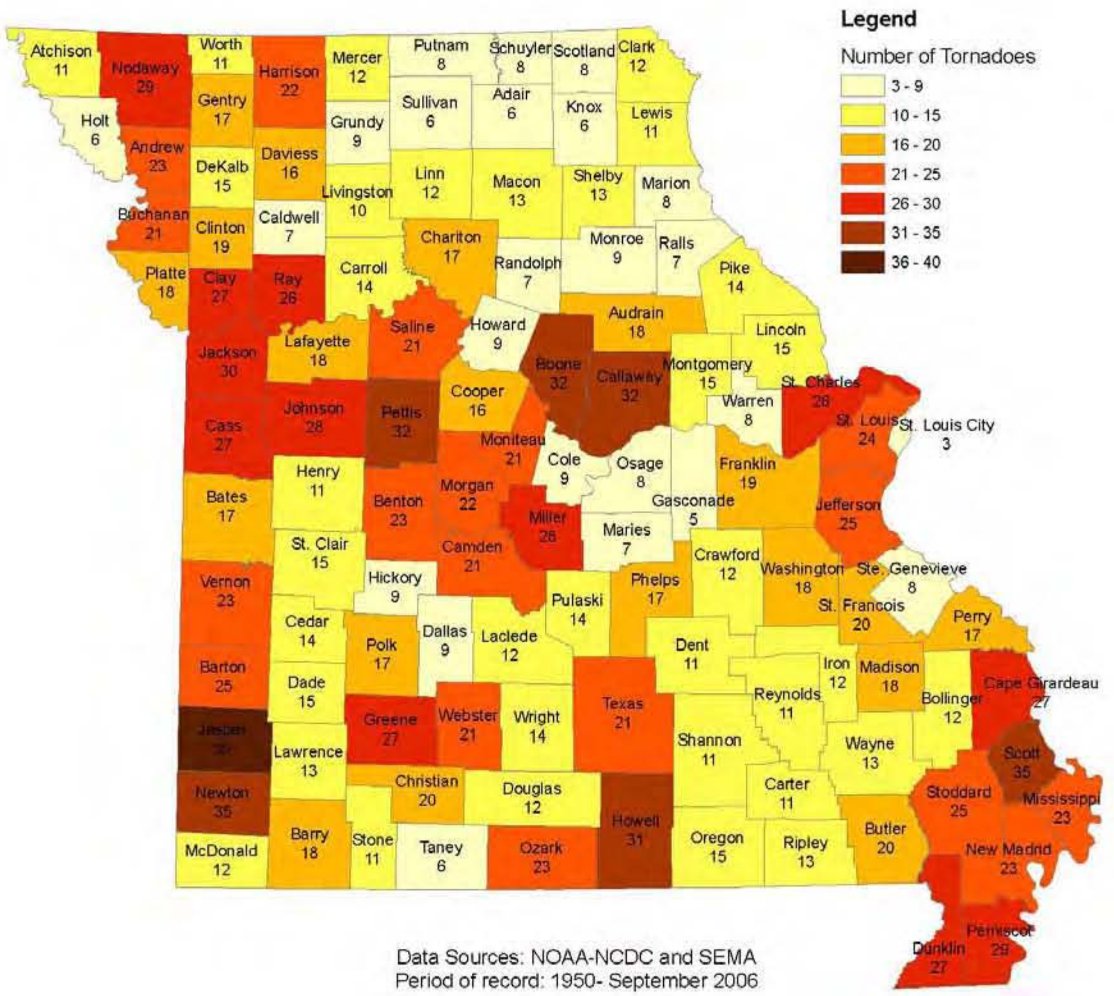


Figure 3.62. Missouri Tornado Deaths by County: Top Ten, 1950–2005

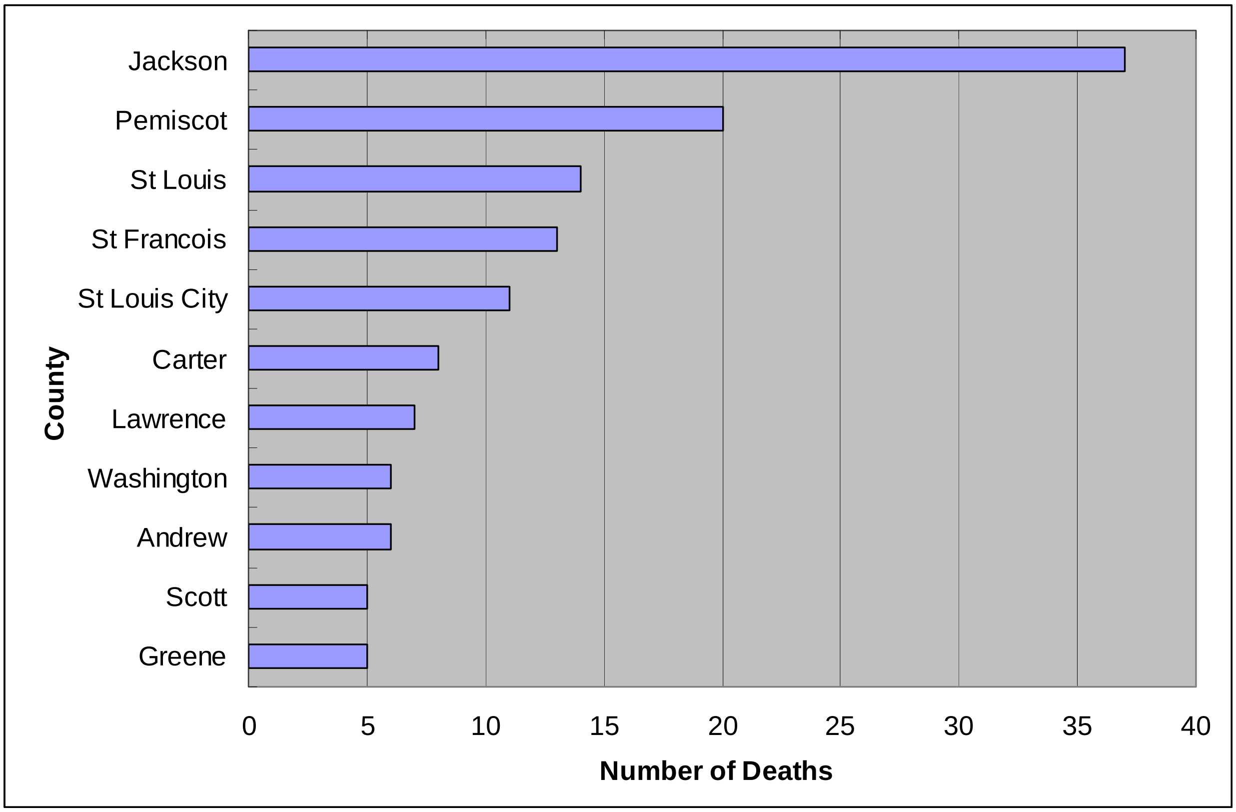
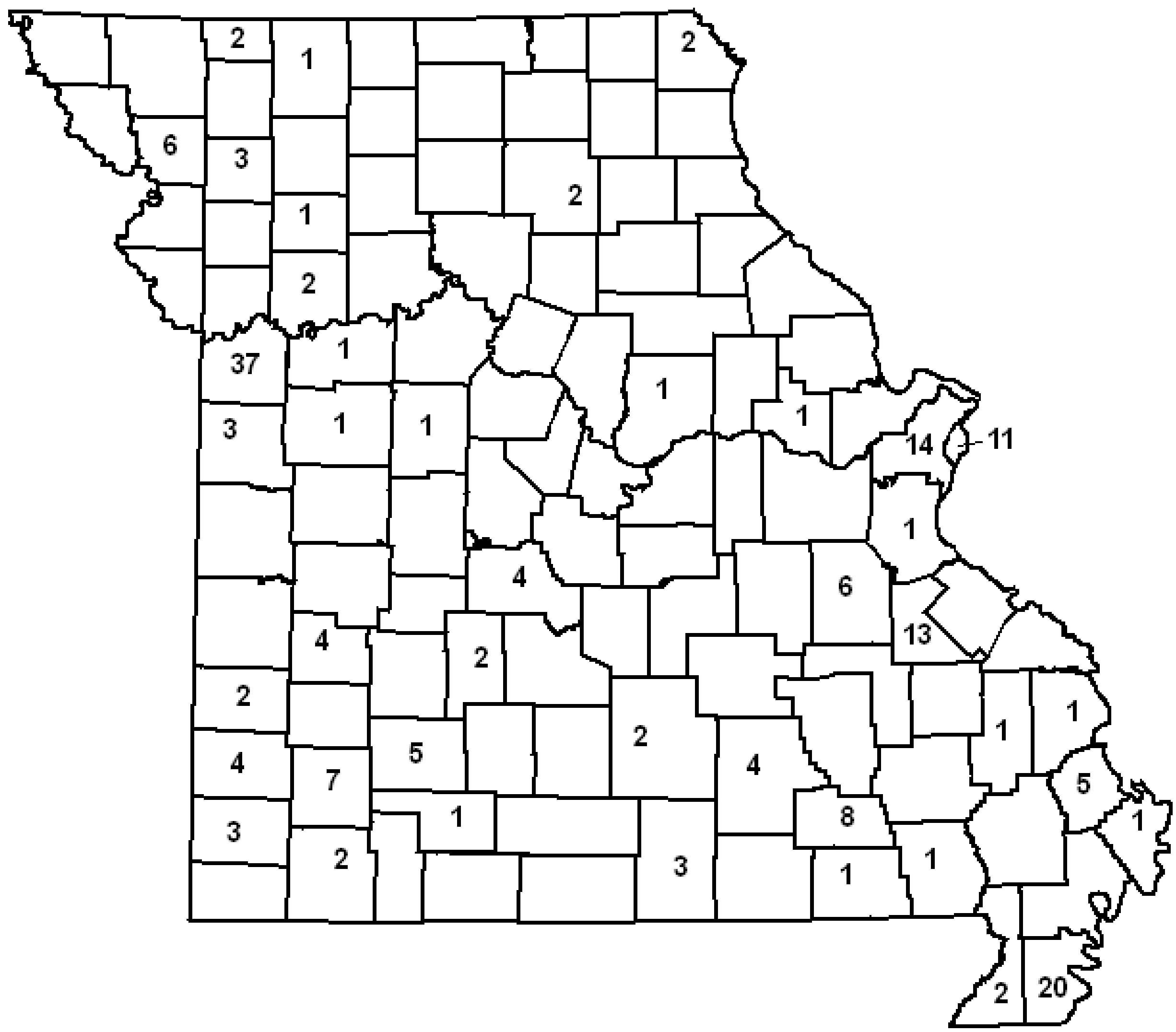


Figure 3.63. Missouri Tornado Deaths by County, 1950–2005



In May 1996, a Memorial Day weekend storm identified by the National Weather Service as a microburst caused more than $10 million in damage to homes in Lee's Summit, Missouri. The storm destroyed at least 13 homes and damaged more than 100 others in several Lee's Summit subdivisions. The city also incurred a substantial cost for debris removal and cleanup activities resulting from this devastating storm.

During the period of 1992 through 1996, seven people died in Missouri as a result of lightning strikes, compared to two deaths from tornadoes during the same period. The thunderstorms associated with tornado development also contribute to the number one weather killer—flash floods. Flash flooding causes 146 deaths annually throughout the nation. During the period from 1992 through 2002, flooding and flash floods claimed the lives of 60 Missourians. Thunderstorms and severe winds claimed five lives over this same period.

According to the National Climatic Data Center's Storm Events database, there were 5,728 hail events, where hail was at least one inch, between 1955 and 2006. (Note: This is a total of events. Events make up episodes. Each episode may have multiple events.) Damage from the events between 1993 and 2006 is estimated at approximately $1.29 billion (in 2006 dollars). Two injuries were reported between 1993 and 2006. This information suggests that Missouri could experience 110 one-inch-size hail events and $92.4 million in hail damage each year. This number is likely skewed by one particularly damaging event in 2001 that caused approximately $1.2 billion in damage in St. Charles and St. Louis counties.

The same database reports 9,463 thunderstorm and high wind events between 1955 and 2006. (Note: This is a total of events. Events make up episodes. Each episode may have multiple events.) Twelve deaths and 276 injuries were reported for this time period. Damage from the events between 1993 and 2006 is estimated at $104 million (in 2006 dollars). This information suggests that Missouri could experience 182 thunderstorm and high wind events annually that could result in $7.4 million in damage and 5 injuries each year.

While property losses from hail and thunderstorms have been significant in Missouri, the damage is often covered by insurance, which is why these incidents do not result in state or federal disaster declarations.

Measure of Probability and Severity

Probability: High
Severity: High

The United States has 10 times more tornadoes than any other nation in the world. Missouri averages 28 tornadoes per year and has recorded 1,584 tornadoes between 1950 and 2005. Missourians have a high probability that tornadoes will continue to affect their lives. The natural phenomena that create tornadoes will continue to occur beyond the ability to control them.

Every tornado is a potential killer, and many are capable of great destruction. Tornadoes can topple buildings, roll mobile homes, uproot trees, hurl people and animals through the air for hundreds of yards, and fill the air with lethal, windblown debris. Sticks, glass, roofing material, and lawn furniture all become deadly missiles when driven by tornado winds. In 1975, a Mississippi tornado carried a home freezer for more than a mile. Once, a tornado in Broken Bow, Oklahoma, carried a motel sign 30 miles and dropped it in Arkansas. Tornadoes do their destructive work through the combined action of their strong rotary winds and the impact of

windblown debris. In the simplest case, the force of the tornado's winds pushes the windward wall of a building inward. The roof is lifted up, and the other walls fall outward. Until recently, this damage pattern led to the incorrect belief that the structure had exploded as a result of the atmospheric pressure drop associated with the tornado.

The information in Table 3.37 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.37. EMAP Impact Analysis: Tornadoes and Severe Storms

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be severe for incident areas and moderate to light for other adversely affected areas.
Health and Safety of Personnel Responding to the Incident	Localized impact expected to limit damage to personnel in the areas at the time of the incident.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the area of the incident. Some severe damage possible.
Delivery of Services	Localized disruption of roads, facilities, and/or utilities caused by incident may postpone delivery of some services.
The Environment	Localized impact expected to be severe for incident areas and moderate to light for other areas affected by the storm or HazMat spills.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time.
Regulatory and Contractual Obligations	Regulatory waivers may be needed locally. Fulfillment of some contracts may be difficult. Impact may temporarily reduce deliveries.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

The enormous power and destructive capability of tornadoes are beyond mankind's capabilities to control. The potential severity of effects from tornadoes will continue to be high. We will continue to experience deaths, injuries, and property damage from tornadoes. However, technological advances will facilitate earlier warnings than previously available. This, combined with a vigorous public education program and improved construction techniques, provides the potential for significant reductions in the number of deaths and injuries, as well as reduced property damage.

Severe thunderstorms losses are usually attributed to associated hazards of hail, downburst winds, lightning and heavy rains. Losses to hail and high wind are typically insured losses that are localized and do not result in presidential disaster declarations. Severe thunderstorms/heavy rains that lead to flooding are accounted for in the riverine flooding profile. SEMA will consider profiling severe thunderstorms separately during the 2008 update to its Hazard Analysis, recognizing that severe thunderstorms do cause problems at a local level.

Separate sections quantify the potential tornado losses to the state and its jurisdictions. These are Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction and Section 3.4 Assessing Vulnerability and Estimating Potential Losses of State Facilities.

3.2.10. Attack (Nuclear, Conventional, Chemical, and Biological)

Description of Hazard

Of all the possible disasters and hazards we can imagine, a strategic nuclear, biological, or chemical attack could have the most devastating and far-reaching consequences. The use of these weapons against the United States is unlikely. Unfortunately, however, as long as such weapons exist, there is always a chance that they could be used. The potential for traditional war-related attacks, using conventional weapons, is a scenario that is more likely to occur, based on currently available information.

Although the threat of all-out nuclear war has been significantly reduced with the dissolution of the former Soviet Union, several scenarios still exist that might subject a jurisdiction to widespread radioactive contamination or high-levels of radiation exposure. When Phase II of the START II Treaty (passed by the U.S. Senate in 1996 and ratified by the Russian Duma in April 2000) is complete, it will allow its signatories, Russia and the United States, to maintain only between 3,000–3,500 actual (versus accountable in the START) strategic nuclear weapons each, a significant reduction from Cold War numbers. Five other nations have declared their nuclear capability and another five are suspected of having developed nuclear weapon technology, including trouble spots, North Korea and Iran. Additionally, 15 nation states have either had weapons or programs to develop nuclear weapons but have reportedly abandoned their efforts. Most have now signed the nuclear nonproliferation treaty. The U.S. Department of Defense estimates that as many as 26 nations may possess chemical agents or weapons, and an additional 12 may be seeking to develop them. The Central Intelligence Agency reports that at least 10 countries are believed to be conducting research on biological agents for weaponization.

While the threat of nuclear attack has diminished over the past several years, concerns over the use of chemical and biological warfare agents have increased. Recent events, such as the September 11, 2001, terrorist attacks on the World Trade Center buildings in New York City and the Pentagon in Washington DC, along with the anthrax-related attacks in 2001, have increased awareness of the vulnerability of the United States to future attacks involving chemical or biological warfare agents. For more information on terrorism-related issues, see Section 3.2.17.

Historical Statistics

Between 960–1279 AD arsenical smoke (a form of chemical warfare) was used in battle during China's Sung Dynasty, and in 1346–1347, Mongols catapulted corpses (biological warfare) contaminated with plague over the walls into Kaffa (in Crimea), forcing besieged Genoans to flee.

During World War I (1915–1918), chemical and conventional weapons were used. The first poison gas, chlorine, was used by the Germans against Allied troops in 1915. The effects of the gas were devastating, causing severe choking attacks within seconds of exposure. The British subsequently retaliated with chlorine attacks of their own, although reportedly more British suffered than Germans, because the gas blew back into their own trenches. Phosgene was later used in the war because it caused less severe coughing, resulting in more of the agent being inhaled. Then, in September 1917, mustard gas was used in artillery shells by the Germans against the Russians. Mustard gas caused serious blisters, both internally and externally, several hours after exposure. In all, there were 1,240,853 gas-related casualties and 91,198 deaths from gas exposure during World War I.

During World War II (1941–1945), atomic (nuclear), chemical, and conventional weapons were used. Use of chemical weapons in World War II was not as prevalent as in World War I and was primarily limited to the Japanese Imperial Army. During the war, the Japanese used various chemical-filled munitions, including artillery shells, aerial bombs, grenades, and mortars, against Chinese military forces and civilians. Chemical agents used included phosgene, mustard, lewisite, hydrogen cyanide, and diphenyl cyanarsine. The war was brought to an abrupt end in 1945, when the United States dropped two atomic bombs on Japan: one on Hiroshima that obliterated the entire city and killed approximately 66,000 people and another on Nagasaki that destroyed about half the city and killed about 39,000 people.

During the Vietnam War (1964–1973), chemical and conventional weapons were used. Chemical weapons used during the Vietnam War are believed to have only involved tear agents used by the United States and possibly psychedelic agents, also by the United States. Although not directly used as warfare agents, toxic herbicides such as Agent Orange were commonly used as defoliants by the United States. Long-term exposure to Agent Orange, which contained the contaminant dioxin, was believed to cause illness and disease in humans.

In 1983, Iraq launched its first of 10 documented chemical attacks against Iran. The largest of these attacks was in February 1986, when mustard gas and the nerve agent tabun were used, impacting up to 10,000 Iranians. Although the exact number of chemical attacks implemented by Iraq during the war is unknown, the Iranian government estimates that more than 60,000 soldiers had been exposed to mustard gas and the nerve agents sarin and tabun by the time the war ended in 1988. Based on these data, the Iraqi chemical attacks during the Iran-Iraq war were the largest since World War I.

Although several isolated attacks involving biological agents have occurred over the last few decades, the most recent series of incidents in the United States that gained nationwide exposure occurred between early October and early December 2001, when five people died from anthrax infection, and at least 13 others contracted the disease in Washington, DC; New York City; Trenton, New Jersey; and Boca Raton, Florida. Anthrax spores were found in a number of government buildings and postal facilities in these and other areas. Most of the confirmed anthrax cases were tied to contaminated letters mailed to media personalities and U.S. senators. Thousands of people were potentially exposed to the spores and took preventive antibiotics. Numerous mail facilities and government buildings were shut down for investigation and decontamination. In the wake of these incidents, federal, state, and local emergency response agencies across the United States responded to thousands of calls to investigate suspicious packages, unknown powders, and other suspected exposures. Fortunately, almost all of these incidents turned out to involve no actual biohazard.

Measure of Probability and Severity

Probability: Low
Severity: High

Attacks against the United States as a whole, and against individual states or local entities, can be categorized as originating from either domestic or international sources. However, because the impacts on life and property would largely be the same regardless of the source of such an attack, similar preparedness, response, and recovery activities apply.

Biological and chemical weapons have often been used to terrorize an unprotected population, instead of actual use as weapons of war. However, the potential damage that can occur in the event of such an attack is huge, particularly to human health.

A single nuclear weapon detonation could cause massive destruction, and all aforementioned types of attacks could cause extensive casualties. An all-out nuclear attack could affect the entire population in the vicinity of the impacted area. Some areas would experience direct weapons effects: blast, heat, and initial nuclear radiation. Other areas would experience indirect weapons effects, primarily radioactive fallout. As long as world leaders maintain rational thinking, the probability of an attack by a nation-state remains low, but does not rule out attack by a terrorist group.

Secondary effects of these attacks, which could severely stress the country, include lack of adequate shelter, food, water, health and medical facilities and personnel, and mortuary services; disruption of communication systems; and power outages. Because of the potential devastation and significant secondary effects caused by this type of attack, the severity is rated high.

Impact of the Hazard

The population is vulnerable to two separate categories of impacts associated with these types of attacks: direct and indirect. For more information on these impacts, which are often connected to terrorist-related activities, see Section 3.2.17 Terrorism.

Direct Effects

These are effects directly associated with detonation or use of the weapon.

Conventional Weapons—Direct effects of conventional weapons generally are related to injuries inflicted by penetration of ammunition rounds or shrapnel from exploding ordnance (mortars, etc.). Injuries from shock waves/blast overpressure near the targets may also occur, along with damage caused by fires produced from incendiary warheads, grenades, and other munitions. In addition, some injuries may occur as a result of flying or falling debris where the weapons are used. Heavy artillery use can also damage roadways and buildings and disrupt utility services for lengthy periods of time.

Chemical and Biological Weapons—Direct effects of chemical weapons involve initial spread of agents and fragmentation of the weapons. Chemical agents are toxins used to produce neurological and pulmonary injuries or death. Biological agents are infectious microbes used to produce illness or death. They can be dispersed as aerosols or airborne particles directly onto a population, producing an immediate effect (a few seconds to a few minutes for chemical agents) or a delayed effect (several hours to several days for biological agents). Severity of injuries depends on the type and amount of the agent used and duration of exposure. Because some biological agents take time to grow and cause disease, an attack using this type of agent may go unnoticed for several days.

Nuclear Weapons—Direct effects include intense heat, blast energy, and high-intensity nuclear radiation. These effects generally will be limited to the immediate area of the detonation (up to 22 miles), depending on weapon size, altitude of burst, and atmospheric conditions.

Agroterrorism—The direct effect of agroterrorism is the intentional introduction of a contagious animal disease or fast spreading plant disease that affects livestock and food crops and disrupts the food supply chain. Agroterrorism could cause disease in livestock, crops, and in some cases (anthrax, or monkey pox, for example), humans. Diseases that can be transmitted to humans from animals are called zoonotic. It would not only require the agriculture industry to destroy livestock and food crops, but also affect the consumer confidence in the food supply resulting in tremendous economic damage for, potentially, an extended period. The food supply could be severely affected not only for the immediate area and the United States, but the world market, since the United States exports huge quantities of food to other nations. Recently, the federal government recognized the vulnerability of the agricultural/food supply industry and potential debilitation from a terrorist incident and acted to protect the resources through presidential decision directives and encouraged complementary state and local actions.

Radiological Weapon—Direct effects of a radiological weapon are the same as a conventional high explosive, but with the added danger posed by exposure to radiological materials. A radiological dispersion device (RDD) or "dirty bomb" will contaminate an area by spreading radiological dust and debris over a large area.

Explosive Weapon (large amount of high explosive)—The direct results of an explosive weapon are immense destruction caused by the blast and could result in multiple fatalities. Instances of these effects include Oklahoma City, Kobhar Towers, the marine barracks in Lebanon, and the African Embassy bombings.

Indirect Effects

These are effects not directly associated with the detonation and use of the weapon.

Conventional Weapons—Unexploded ordnance throughout a battle zone or explosion hazards to those in the area can persist after warfare has ended. Many conventional munitions also contain toxic compounds that can leach into surrounding soils and groundwater if left in place.

Chemical and Biological Weapons—Indirect effects are generally limited to downwind areas. They can be geographically widespread and vary in intensity—depending on weapon size, type of chemical or biological agent, and wind patterns. The spread of these agents can contaminate food and water supplies, destroy livestock, and ravage crops.

Nuclear Weapons—When a nuclear weapon detonates, intense heat, blast, and overpressure will cause severe injuries and fatalities in the surrounding area and radiation poisoning at more distant locations. A detonation near or on the ground draws up large quantities of earth and debris into a mushroom cloud. This material becomes radioactive, and the particles can be carried by wind hundreds of miles before they drop back to earth as "fallout." In an attack, many areas of the United States would probably escape fallout altogether or experience nonlifethreatening levels of radiation. However, because weather that determines where fallout will land is so unpredictable, no locality in the United States is free from risk of receiving deadly radiation levels after a strategic attack. Less than lethal exposures will result in longer-term effects on health and contamination of food, water, and food production.

Agroterrorism—Agroterrorism's indirect effects are loss of breeding stock to replenish herds and flocks, loss of seed crops, and possibly loss of land use for a long period of time depending on the disease involved. Agroterrorism has a high probability of creating an economic disaster for states highly vested in food production, and potentially the nation.

Radiological Weapon—The indirect effect of an RDD is inability to use the contaminated area for a short to long period of time, depending on the identity of the radioactive material. Because radioactive material from an RDD can penetrate wood, asphalt, concrete, and masonry (and radioactive dust and particles can enter the smallest crevices), decontamination will be extremely difficult or impossible.

Explosive Weapon (large amount of high explosive)—The indirect effect of an explosive weapon is the fear, terror, and lasting psychological damage to survivors and other individuals.

The information in Table 3.38 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.38. EMAP Impact Analysis: Attack

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Health and Safety of Personnel Responding to the Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for trained and protected personnel.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require relocation of operations and lines of succession execution.
Property, Facilities, and Infrastructure	Damage to facilities and infrastructure in the area of the incident may be extensive for explosion, moderate to light for HazMat.
Delivery of Services	Disruption of lines of communication and destruction of facilities may extensively postpone delivery of services.
The Environment	May cause extensive damage, creating denial or delays in the use of some areas. Remediation needed.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time.
Regulatory and Contractual Obligations	Regulatory waivers may be needed. Fulfillment of contracts may be difficult. Demands may overload ability to deliver.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

Even though the START treaty has reduced the overall number of nuclear weapons, and many chemical/biological weapons stockpiles have been destroyed, we must continue to plan for, and be prepared for, this type of hazard. In many ways, while the risk of a nuclear exchange by the super powers is greatly reduced, the potential risk of proliferation of weapons of mass destruction is greater than during the Cold War era.

While it may not be possible to prevent such an attack, steps can be taken to lessen the likelihood and the potential effects of an incident by implementing certain measures:

- Identifying and organizing resources
- Conducting a risk or threat assessment and estimating losses
- Identifying mitigation measures that will reduce the effects of the hazards and developing strategies to deal with the mitigation measures in order of priority
- Implementing the measures and evaluating the results (and keeping the plan up-to-date)

3.2.11 Civil Disorder

Description of Hazard

Civil disorder is a term that generally refers to groups of people purposely choosing not to observe a law, regulation, or rule, usually in order to bring attention to their cause, concern, or agenda. In Missouri, state statutes define civil disorder as “any public disturbance involving acts of violence by assemblages of three or more persons, which cause an immediate danger of or results in damage or injury to the property or person of any other individual.”

Civil disorder can take the form of small gatherings or large groups blocking or impeding access to a building or disrupting normal activities by generating noise and intimidating people. They can range from a peaceful sit-in to a full-scale riot in which a mob burns or otherwise destroys property and terrorizes individuals. Even in its more passive forms, a group that blocks roadways, sidewalks, or buildings interferes with public order. In the 1990s, abortion clinics, for example, were targets for these disruptive-type activities.

Throughout this country’s history, incidents that disrupted the public peace have figured prominently. The constitutional guarantees allow for ample expression of protest and dissent, and in many cases collide with the preamble’s requirement of the government “to ensure domestic tranquility.” Typical examples of such conflicting ideology include the protest movements for civil rights in the late 1960s and the Vietnam War protest demonstrations in the early 1970s. The balance between an individual’s and group’s legitimate expression of dissent and the right of the populace to live in domestic tranquility requires the diligent efforts of everyone to avoid such confrontations in the future.

In modern society, laws have evolved that govern the interaction of its members to peacefully resolve conflict. In the United States, a crowd itself is constitutionally protected under “the right of the people to peacefully assemble.” However, assemblies that are not peaceable are not protected, and this is generally the dividing line between crowds and mobs. The laws that deal with disruptive conduct are generally grouped into offenses that disturb the public peace. They range from misdemeanors, such as blocking sidewalks or challenging another to fight, to felonies, such as looting and rioting. Missouri law makes “promoting civil disorder in the first degree” a class C felony, according to Section 574.070 of the Revised Missouri Statutes. As stated in one provision of the law, “Whoever teaches or demonstrates to any other person the use, application, or construction of any firearm, explosive, or incendiary device capable of causing injury or death to any person, knowing or intending that such firearm, explosive or incendiary

device be used in furtherance of a civil disorder, is guilty of promoting civil disorder in the first degree."

Types of Crowds

A crowd may be defined as a casual, temporary collection of people without a strong, cohesive relationship. Crowds can be classified into four general categories:

- **Casual Crowd—**A casual crowd is merely a group of people who happen to be in the same place at the same time. Examples of this type include shoppers and sightseers. The likelihood of violent conduct is all but nonexistent.
- **Cohesive Crowd—**A cohesive crowd consists of members who are involved in some type of unified behavior. Members of this group are involved in some type of common activity, such as worshiping, dancing, or watching a sporting event. Although they may have intense internal discipline (e.g., rooting for a team), they require substantial provocation to arouse to action.
- **Expressive Crowd—**An expressive crowd is one held together by a common commitment or purpose. Although they may not be formally organized, they are assembled as an expression of common sentiment or frustration. Members wish to be seen as a formidable influence. One of the best examples of this type is a group assembled to protest something.
- **Aggressive Crowd—**An aggressive crowd is made up of individuals who have assembled for a specific purpose. This crowd often has leaders who attempt to arouse the members or motivate them to action. Members are noisy and threatening and will taunt authorities. They tend to be impulsive and highly emotional and require only minimal stimulation to arouse them to violence. Examples of this type of crowd include demonstrations and strikers.

Types of Mobs

A mob can be defined as a large disorderly crowd or throng. Mobs are usually emotional, loud, tumultuous, violent, and lawless. Like crowds, mobs have different levels of commitment and can be classified into four categories:

- **Aggressive Mob—**An aggressive mob is one that attacks, riots, and terrorizes. The object of violence may be a person, property, or both. An aggressive mob is distinguished from an aggressive crowd only by lawless activity. Examples of aggressive mobs are the inmate mobs in prisons and jails, mobs that act out their frustrations after political defeat, or violent mobs at political protests or rallies.
- **Escape Mob—**An escape mob is attempting to flee from something such as a fire, bomb, flood, or other catastrophe. Members of escape mobs have lost their capacity to reason and are generally impossible to control. They are characterized by unreasonable terror.
- **Acquisitive Mob—**An acquisitive mob is one motivated by a desire to acquire something. Riots caused by other factors often turn into looting sprees. This mob exploits a lack of control by authorities in safeguarding property. Examples of acquisitive mobs would include the looting in South Central Los Angeles in 1992, or food riots in other countries.

- **Expressive Mob**—An expressive mob is one that expresses fervor or revelry following some sporting event, religious activity, or celebration. Members experience a release of pent up emotions in highly charged situations. Examples of this type of mob include the June 1994 riots in Canada following the Stanley Cup professional hockey championship, European soccer riots, and those occurring after other sporting events in many countries, including the United States.

Although members of mobs have differing levels of commitment, as a group they are far more committed than members of a crowd. As such, a "mob mentality" sets in, which creates a cohesiveness and sense of purpose that is lacking in crowds. Thus, any strategy that causes individual members to contemplate their personal actions will tend to be more effective than treating an entire mob as a single entity.

Historical Statistics

Missouri

Fortunately, Missouri has not experienced a trend of consistent riotous behavior or disruptive civil disorder, as some other states have witnessed in the past several decades. While far from recent, Missouri's most notable incident is the famous 1954 prison riot in Jefferson City, which stands as the state's worst-case example of a full-scale riot. Other events in Missouri's early history, as well as those from the late 1960s through this decade, indicate the state is not immune to riots, protests, and social upheaval, but no event caused the destruction that occurred during the 1954 prison riot. Some brief examples of Missouri's riotous events are provided below.

In the spring of 1832, citizens in Jackson County began to show their hostility toward Mormon newcomers by stoning their houses. In July 1833, a public meeting to determine the Mormon question resulted in demands that no more Mormons be allowed to settle there, that Mormons already residing in the county move out immediately, and that the Mormon newspaper (the Evening and Morning Star) be suspended. When the Mormon settlers refused these demands, the citizens razed the newspaper office, threw the press in the Missouri River, and tarred and feathered two Mormons. The Mormons appealed their plight to Governor Daniel Dunking, who issued a decision denying any citizen the right to take into his own hands the redress of grievances. He recommended that the Mormons take their case to civil court to uphold their rights. Incensed by this action, about 50 armed men attacked a Mormon settlement called Big Blue near Independence on October 31, 1833, beating several of the men and destroying 10 homes. Hostilities continued the next two nights. On November 4, a band of citizens fought about 30 Mormons at Big Blue; three citizens, including one Mormon, were killed. Feeling they were outnumbered, most of the Mormons left the county as a result. The few who remained eventually left as well due to continued threats and hostilities.

In 1906, on the night before Easter Sunday in Springfield, a mob of 6,000, fueled by alcohol and rumors of a white woman's rape, battered down the jailhouse doors and carried away three black men and hanged them in the town square. Within hours, new rumors spread that black

neighborhoods were about to be destroyed. Hundreds of black people fled before the state militia arrived to restore order. In the months that followed, a grand jury indicted more than a dozen people for the hangings, and the story of the woman's attack proved to be untrue. Only one person went to trial, however, and the jury deadlocked without reaching a verdict. In her book about the incident and its aftermath, "Many Thousand Gone," Katherine Lederer notes that until 1906, Springfield had a thriving black population, but the population has never recovered.

On September 22, 1954, a full-scale riot broke out at the Men's State Penitentiary in Jefferson City at about 6:00 p.m., after an inmate released several prisoners. The inmate had obtained keys from a guard by a ruse. At 7:00 p.m., all available state highway patrolmen were directed to report to the penitentiary as quickly as possible to quell the riot. Several buildings and vehicles were burning at that time, and some 500 inmates were loose, hurling bricks, yelling, and attempting to escape. Both chapels were ablaze, as well as several prison shops and factories. Seeing the fires, which were visible at dusk from about 20 miles away, prisoners at the Algoa reformatory and the women's prison staged separate rebellions there. Damage to state property at those facilities was minimal, but at the main prison, only cell houses and buildings equipped with sprinklers survived. By 11:30 p.m., 285 patrolmen in 202 cars were on the scene, and by midnight, some 100 St. Louis policemen carrying submachine guns had arrived by special train. They surrounded cell houses B and C—the only halls in which guards were still held hostage. Highway patrolmen and arriving National Guardsmen took positions on rooftops overlooking the quadrangle—a yard between the larger cell houses. From that vantage point, they opened fire, seriously wounding many inmates in the exchange. Shortly after 7:00 a.m. the next day, the last guard taken hostage was released, and the rioters, having no alternative, gave up shortly thereafter. By mid-morning, 2,000 police officers and National Guardsmen were on duty at the prison. When the riot was ly over, 3 inmates had been killed and 21 wounded by gunfire. One other prisoner was murdered by stabbing and beating, and eight others were injured in fighting with each other. Five buildings were completely destroyed, and two others partially destroyed, resulting in more than $10 million in losses to state property.

On October 23, 1954, another riot occurred at the State Penitentiary while state troopers were still technically operating the institution. This melee was between white and black inmates and started over food. Bricks began to fly, followed by gunfire from the troopers. Approximately 35 prisoners were wounded in that incident.

On the evening of March 19, 1958, at the Algoa Intermediate Reformatory, east of Jefferson City, quick action by then Governor James T. Blair and a contingent of state highway patrolmen with riot guns quelled a potential inmate uprising. The governor himself and the patrolmen entered the facility amid reports of unrest following the resignation of the institution's acting superintendent. When no trouble occurred, the troopers were removed after about two hours.

On April 9, 1968, the Kansas City Police Department requested the help of the Missouri Highway Patrol in quelling rioting, bombing, and looting in the eastern part of the city in the wake of the assassination of Martin Luther King, Jr. Over 200 officers reported to the staging

area at District Four of the State Highway Department to receive their assignments and began patrolling the downtown area. Officers arrested numerous persons for charges ranging from curfew violations to felonious assault. They remained on duty for 10 days until peace was restored.

Twice in May 1969, demonstrations at Lincoln University in Jefferson City resulted in about 200 highway patrolmen being called to the scene to combat arson, sniper fire, and vandalism on campus. The Student Union was burned during those demonstrations.

On February 17, 1975, at Algoa Intermediate Reformatory, a minor riot broke out, resulting in tear gas being thrown into dormitories at the institution. Three prison officials suffered minor injuries, and one inmate required stitches to close a wound. The incident resulted in about $5,000 in property damage.

In December 1977 and January 1978 in Southeast Missouri, farmers making up an American Agricultural Movement staged demonstrations to protest what they felt were unfair prices for their products, as maintained by government price supports. The rallies continued through April 1978 with picketing, tractorcades, and stoppage of highway traffic throughout the area, despite high winds, ice, and snow. More than 300 farm tractors were involved in at least one of these actions. On January 11, highway patrol troopers on Interstate 55 near Hayti arrested seven farmers and charged them with failure to obey a reasonable request, assault, and damaging state property. Four others were arrested on I-55 near Caruthersville for driving their pickup trucks slowly side by side, preventing traffic from passing. Twenty-five farmers with their tractors were involved in a fracas with 12 officers near Hayti. Two patrol cars were damaged, and one officer sustained minor injuries when shoved by an irate farmer into the path of a road grader.

On April 29, 1992, in Warrensburg, racial tensions mounted following the announcement of the controversial Rodney King verdict. The Johnson County Emergency Operations Center was activated for several hours as police remained on alert status for a potential serious disturbance. Military police from nearby Whitman Air Force Base were also placed on standby alert status, but no major problems occurred.

United States

Incidents of civil disorder that erupted into violence are part of American history, spanning several centuries. In March 1770, just prior to the Revolutionary War, a riot occurred when Boston citizens jeered and taunted British soldiers and began throwing things at them during a demonstration. Five people were killed when the troops fired during the incident, which became known as “The Boston Massacre.” Three years later, on December 16, 1773, a group of Boston citizens protested the British tax on tea by throwing it overboard. The “Boston Tea Party” was a harbinger of troubles that eventually led to the Revolutionary War.

On May 4, 1886, another violent event occurred in Haymarket Square in Chicago when a confrontation took place between police and strikers at the McCormick reaper works. A bomb

was thrown and a gun battle erupted, during which seven police officers and four workers were killed. Many police and civilians were also injured in what became known as the "Haymarket Square Riot."

Controversy over civil rights and the unpopular war in Vietnam during the 1960s and 1970s resulted in one of the most turbulent periods in American history. During this same time, major riots occurred in Los Angeles (1965); Detroit (1967); Chicago (1968, during the Democratic National Convention); Santa Barbara, California (1970); East Los Angeles (1970 and 1971); and Attica, New York (1971, during a major prison riot). Violent rioting once again erupted across the country on April 29, 1992, when four police officers were acquitted after being accused of beating a black suspect (Rodney King). Also in recent years, issues such as abortion, gay rights, immigration, and gun control have generated great public debate and resulted in many mass assemblies and demonstrations.

Measure of Probability and Severity

Probability: Low
Severity: Low to High

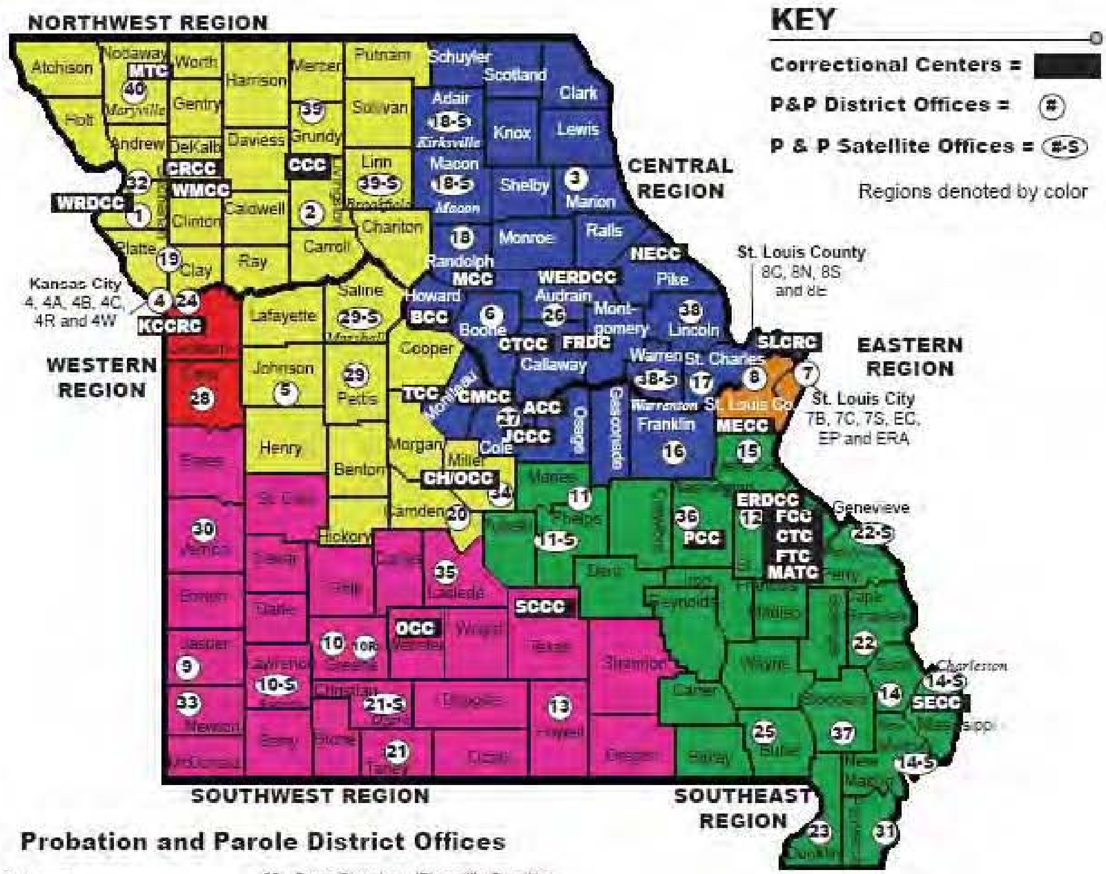
Across the nation, police reports reflect a fairly steady rate of theft, mugging, arson, and homicide incidents. But these criminal acts do not amount to "riots." In their article on "Understanding Riots" published in the *Cato Journal* (Vol. 14, No 1), David D. Haddock and Daniel D. Polsby note that a large crowd itself is not an incipient riot merely because it assembles a great many people. Haddock and Polsby explain that "starting signals" must occur for civil disorder to erupt; these starting signals include certain kinds of high profile events. In fact, incidents can become signals simply because they have been signals in the past. In Detroit, for example, Devils Night (the night before Halloween) has in recent years become a springboard for multiple, independent, and almost simultaneous acts of arson. With any conventional triggering event, such as news of an assassination or unpopular jury verdict, crowds form spontaneously in various places as word of the incident spreads, without any one person having to recruit them. But since not every crowd threatens to evolve into a riot, the authors reason that a significant number of people must expect and desire that the crowd will become riotous. In addition, "someone has to serve as a catalyst—a sort of entrepreneur to get things going." A typical action is the breaking of a window (a signal that can be heard by many who do not necessarily see it). Someone will throw the first stone, so to speak, when he calculates the risk of being apprehended has diminished to an acceptable level. This diminished risk is generally based on two variables—the size of the crowd relative to the police force and the probability that others will follow if someone leads. The authors conclude that once someone has taken a risk to get things started, the rioting will begin and spread until civil authorities muster enough force to make rioters believe they face a realistic prospect of arrest.

Nationwide, riots are apt to be a recurrent, if unpredictable, feature of social life. Without question, Missouri will continue to experience future episodes of marches, protests,

demonstrations, and gatherings in various cities and communities that could lead to some type of disruptive civil disorder. However, based on the state's general history of civil disturbance and the various human factors noted above, the probability that such incidents will develop into full-scale riots is considered low.

Regarding penal institutions, much has been done in Missouri and other states to alleviate living conditions, which are underlying factors in many riots (prison overcrowding, poor treatment of inmates, lack of grievance procedures, etc.). The state has been building new prisons for several years and expanding facilities to create more space and otherwise improve facilities for its inmate population. As of September 15, 2005, 31,185 inmates were housed in the 20 state correctional centers. A map of the correctional institutions and probation and parole offices in the state is provided as Figure 3.64. One federal prison is located in the state, in Springfield.

Figure 3.64. Correctional Institutions and Probation and Parole Offices



Probation and Parole District Offices

1. St. Joseph
2. Chillicothe
3. Hannibal
4. Kansas City (6 offices)
5. Warrensburg
6. Columbia
7. St. Louis City (6 offices)
8. St. Louis County (4 offices)
9. Joplin
10. Springfield (2 offices and Aurora Satellite
11. Rolla (Steelville Satellite)
12. Farmington
13. West Plains
14. Sikeston (Charleston and New Madrid Satellites)
15. Hillsboro
16. Union
17. St. Charles
18. Moberly (Macon and Kirksville)
19. Liberty
20. Camdenton
21. Branson (Ozark Satellite)
22. Cape Girardeau (Perryville Satellite)
23. Kennett
24. Independence
25. Poplar Bluff
26. Fulton
27. Jefferson City
28. Belton
29. Sedalia (Marshall Satellite)
30. Nevada
31. Caruthersville
32. St. Joseph
33. Neosho
34. Eldon
35. Lebanon
36. Potosi
37. Dexter
38. Troy (Warrenton Satellite)
39. Trenton (Brookfield Satellite)
40. Maryville

KCCRC: Kansas City Community Release Center
SLCRC: St. Louis Community Release Center

Correctional Centers

ACC - Algoa Correctional Center, Jefferson City
BCC - Boonville Correctional Center, Boonville
BTC - Boonville Treatment Center, Boonville
CMCC - Central Missouri Correctional Center, Jefferson City
CCC - Chillicothe Correctional Center, Chillicothe
CRCC - Crossroads Correctional Center, Cameron
ERDCC - Eastern Reception, Diagnostic & Correctional Center, Bonne Terre
FCC - Farmington Correctional Center, Farmington
CTC - Community Therapeutic Center, Farmington
FTC - Farmington Treatment Center, Farmington
MATC - Mineral Area Treatment Center, Mineral Point
SRU - Social Rehabilitation Unit, Farmington
FRDC - Fulton Reception & Diagnostic Center, Fulton
CTCC - Cremer Therapeutic Community Center, Fulton
KCCRC - Kansas City Community Release Center
MTC - Maryville Treatment Center, Maryville
MECC - Missouri Eastern Correctional Center, Pacific
MCC - Moberly Correctional Center, Moberly
NECC - Northeast Correctional Center, Bowling Green
OCC - Ozark Correctional Center, Fordland
CH - Camp Hawthorn, Kaiser
PCC - Potosi Correctional Center, Potosi
SCCC - South Central Correctional Center, Licking
SECC - Southeast Correctional Center, Charleston
TCC - Tipton Correctional Center, Tipton
WMCC - Western Missouri Correctional Center, Cameron
WRDCC - Western Reception, Diagnostic & Correctional Center, St. Joseph
WRTC - Western Region Treatment Center
WERDCC - Women's Eastern Reception, Diagnostic & Correctional Center, Vandalia

Source: Missouri Department of Corrections Division of Adult Institutions

Should Missouri experience future incidents of disruptive civil disorder or rioting, the severity of a given event could range from low to high, depending on many factors. A spirited demonstration that gets out of hand may result in several arrests, minor damage to property (police vehicles with broken windows, etc.), some injuries, and manpower/overtime costs for police, fire, and other response services. To a greater extent, the threat of urban or intercity riots has the potential for millions of dollars in property damage, possible loss of life, and serious injuries, and extensive arrests. Sustaining police at the scene for extended periods, and possibly mobilizing state highway patrol and National Guard units, can add to the extensive manpower costs. Still, such riots tend to be confined to a single site or general area of a community rather than multiple locations or several areas of the state at the same time. Once a riot has occurred, police in other cities are generally on standby for possible riotous conditions and are better able to alleviate potential disturbances before they develop into full-scale riots.

Impact of the Hazard

When rioting does break out, it generally proves extremely difficult for first-responder law enforcement authorities to quell the mob promptly. The rules of constitutional law set stringent limits on how police officers can behave toward the people they try to arrest. Restraint also plays a crucial part in avoiding any action that “fans the flames.” Initial police presence is often undermined because forces may be staffed below the peak loads needed to bring things back under control. At a result, the riot may continue until enough state police or National Guard units arrive to bolster the arrest process and subsequently restore order. In many cases, damage to life and property may already be extensive.

The information in Table 3.39 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.39. EMAP Impact Analysis: Civil Disorder

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Health and Safety of Personnel Responding to the Incident	Localized impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require temporary relocation of operations.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the area of the incident. Some severe damage possible.
Delivery of Services	Localized disruption of lines of communication and destruction of facilities may postpone delivery of some services.
The Environment	May cause extensive damage in isolated cases and some denial or delays in the use of some areas. Remediation needed.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time, depending on damage.
Regulatory and Contractual Obligations	Regulatory waivers may be needed. Fulfillment of some contracts may be difficult. Impact may reduce deliveries.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

In the wake of numerous urban riots in the late 1960s and beyond, a unique approach in law enforcement began to emerge as a viable means to reduce the risk of such future riots. Known as "community policing," its philosophy rests on the belief that reducing and controlling serious crime requires the police to pay renewed attention to all problems that allow serious crime to occur. In its comprehensive report following the devastating 1967 Detroit riot for example, the Kerner Commission noted that police "cannot, and should not, resist becoming involved in community service matters." The benefits to law enforcement and public order, the commission says, include the following:

- Because of their “front-line position” in dealing with ghetto problems, police will be better able to identify problems in their community that may lead to disorder.
- They will be better able to handle incidents requiring police intervention.
- Willing performance of such work can gain police the respect and support of the community.
- Development of nonadversary contacts can provide the police with a vital source of information and intelligence concerning the communities they serve.
- In his paper entitled “Preventing Civil Disturbances: A Community Policing Approach,” Michigan State University professor Robert C. Trojanowicz says community policing can reduce the potential for riots beyond simply reducing racial tensions between the police and the black community. The organizational strategy of community policing, he writes, “requires freeing some police officers from the isolation of the patrol car, so they can work directly in the community and enlist them as partners in the process of policing themselves. It addresses the need that everyone in the United States deserves to live in a safe and stable community, free of drugs and violence, and reminds us that “until we are all safe, no one is safe.” Four basic ways community policing can help in riot prevention, the author says, are as follows:
  - It provides a means of gathering superior intelligence that allows us to identify areas at risk, the level of threat in those areas, and weaknesses and strengths within the community.
  - It provides the police with a way to address those weaknesses, which often include crime, violence, drugs, fear of crime, disorder, neighborhood decay, and juveniles at risk.
  - It reaches out to law-abiding people in the community and involves them in the police process, serving as the vital link required to enlist their help in actively promoting order and stability.
  - It reduces the overall risk to riots by improving the relations between the police and the black community.
- A community policing officer (CPO), the author notes, is a full-fledged law enforcement officer who makes arrests but is further challenged to find new ways to address old problems. CPOs act as community advocates for needed neighborhood services (prompt trash pickup, demolition of abandoned buildings, etc.) and serve as community liaison to public and private agencies, Trojanowicz writes. “This can mean linking troubled families to affordable counseling services, linking the homeless to shelter, or tapping local business to provide donated supplies for projects to beautify the area.” The initiatives are bounded only by the collective imagination of the CPO and the people in the community and their local needs, the author concludes.

3.2.12 Hazardous Materials Release (Fixed Facility and Transportation Accidents)

Description of Hazard

A hazardous material is any substance or material in a quantity or form that may pose a reasonable risk to health, the environment, or property. The category hazardous materials includes incidents involving substances such as toxic chemicals, fuels, nuclear wastes and/or products, and other radiological and biological or chemical agents. For the purposes of this Hazard Analysis section, only accidental or incidental releases of hazardous materials from two different kinds of incidents are addressed: fixed facility incidents and transportation-related accidents. In consideration of recent worldwide and national events, incidents involving terrorism or national attacks, which involve hazardous materials of any type, are addressed in Section 3.2.17 Terrorism, Section 3.2.10 Attack, and Section 3.2.16 Special Events.

Generally, with a fixed facility, the hazards are pre-identified, and the facility is required by law to prepare a risk management plan and provide a copy to the local emergency planning committee (LEPC) and local fire departments. Missouri Tier II forms must also be filed with the Missouri Emergency Response Commission at SEMA. For specific site plans, each county LEPC is required by law to maintain a copy of these plans.

The exact location of a hazardous materials accident is not possible to predict. The close proximity of railroads, highways, airports, waterways, pipelines, and industrial facilities to populated areas, schools, and businesses could put a large number of individuals in danger at any time. In addition, essential service facilities, such as police and fire stations, hospitals, nursing homes, and schools near major transportation routes in the state are also at risk from a potential hazardous materials incident.

Federal Highway Administration statistics indicate that 1 of 10 motor vehicles is engaged in the transport of hazardous materials of some type. The U.S. Army Corps of Engineers also indicates that over 9,000 tons of petroleum products and over 200,000 tons of chemicals and related products are shipped annually by river barge via the Missouri River between Omaha and Kansas City.

Previous estimates have indicated that, nationwide, over four billion tons of hazardous materials are shipped each year by various transportation modes. Approximately 20 flights each day out of Lambert Airport in St. Louis carry nuclear medicines, and Tri-State Motor Transit Company of Joplin has approximately 25 shipments of high explosives each week.

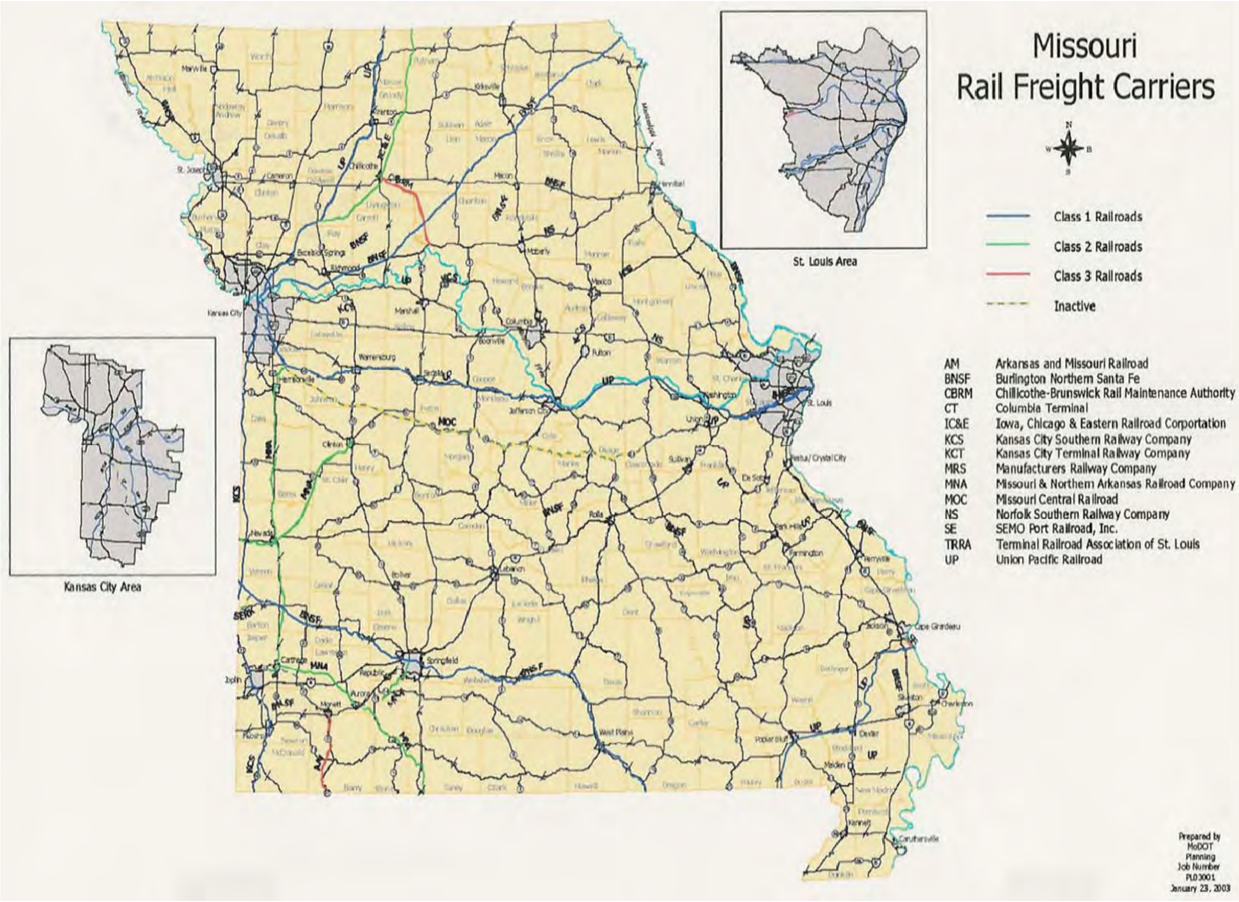
Missouri is also at risk because of the highway system and geographical location. With Interstate highways such as I-29, I-35, I-44, I-55, and I-70, Missouri offers premium routes for commercial carriers traversing the continental United States. Even arterial highways in Missouri, such as U.S. Highways 71, 13, 63, 54, and 61 are maintained to provide more favorable traveling conditions than in other central states. Also, the locations of nuclear facilities in relation to mines

and fuel processing plants result in shipments of radioactive products and wastes across Missouri.

Missouri is at the crossroads for rail and truck transport of nuclear waste to the Yucca Mountain, Nevada, test site. Truck shipments alone will affect 25 different states, 266 counties, and two Indian reservations. This will be a potentially large waste shipping campaign from as many as 19 nuclear reactors through other corridor states to Nevada.

The railroad systems in Missouri transport voluminous types and amounts of hazardous materials on their 6,351 miles of rails that traverse the state (see Figure 3.65). Though individual cars may be placarded to reveal contents such as hazardous materials, only estimates can be obtained concerning volumes of such materials, because only the interstate traffic is counted or measured. Interstate shipments are accounted for where they originate and terminate.

Figure 3.65. Missouri Rail Freight Carriers System Map



Increased use and transport of materials across the country has created serious problems for emergency services personnel. Many factors can increase the magnitude of an otherwise simple transportation accident into an incident of potential hazard to high numbers of people. Following are potential factors to be considered:

- Over 14,000 different chemicals are estimated as being shipped by the various transportation modes. Some types of highly toxic chemicals do not require placarding if shipped in quantities of less than 1,000 pounds, even though lesser quantities could devastate a small town.
- Only a few emergency response organizations in the larger cities and counties near the more metropolitan areas have had training for handling peacetime radiological problems. With recent federal grants and programs in place to provide funding for training, exercises, and equipment for state Homeland Security Response Teams and local responders, the general capabilities of hazardous materials response personnel and teams statewide is expected to improve. Refer to Section 3.2.17 Terrorism for more information on this topic.
- There is a general lack of intelligence reports regarding activity of possible terrorists.

Other scenarios involve nuclear terrorism and faulty reentry of nuclear-equipped satellites to earth (such as COSMOS 954 in 1978 and SKYLAB in 1980). However, transport of radioactive materials presents the most probable scenario for a radiological incident. The U.S. Department of Energy is currently shipping radioactive waste by truck to repositories in Texas and Utah. These trucks cross Missouri through St. Louis and Springfield on I-270 and I-44.

The federal government has ized development of long-term repositories for spent fuel and other high-level radioactive wastes, and for transuranics (known as TRU waste), at Yucca Mountain, Nevada, and Carlsbad, New Mexico, respectively. Speculations have suggested that up to 3,600 shipments per year may go to these facilities, depending on several variables.

A large number of hazardous material shipments come from two corporations in Missouri. Tyco/ Mallinckrodt Medical in Maryland Heights (St. Louis County) and Tri-State Motor Transit in Joplin (Jasper County). Tyco/Mallinckrodt Medical is one of the largest manufacturers of radiopharmaceuticals in the world. Tri-State is one of the largest single private carriers of radioactive materials in the world, in addition to transporting all classes of explosive materials and other toxic and hazardous materials.

Missouri is a transportation hub. The interstate corridors of I-44, I-70, and I-55 are the most commonly used for truck transport. U.S. Highway 36 crosses the northern counties, while U.S. Highway 60 crosses the southern counties. U.S. Highways 71, 13, 65, and 63 are also well-traveled north-south arterial routes.

Although there are railroads throughout Missouri, the UP route between St. Louis and Kansas City is the most used for large radioactive material shipments. Combined, the switching yards at St. Louis and Kansas City process more of these transcontinental trains than any other yards in the country.

During any radiological emergency, regardless of the cause, local officials and emergency responders will likely require state or federal support in the detection, monitoring, and analysis of radiological data for decision-making.

In 1990, the Agency for Toxic Substances and Disease Registry (ATSDR) of the Centers for Disease Control and Prevention (CDC) began funding selected state health departments to participate in the Hazardous Substances Emergency Events Surveillance (HSEES) system. Missouri was added to this effort in fiscal year 1994 and became the twelfth participating state. The Missouri Department of Health and Senior Services (DHSS) administers Missouri's HSEES participation. The goal of this surveillance project is to provide data in an effort to reduce injuries and deaths to first responders, employees, and the general public from hazardous substance emergencies.

Beginning in 2002, a newly updated data-collection form, approved by the Office of Management and Budget, went into effect. For each event, information was collected about the event, substance(s) released, victims, injuries, and evacuations.

HSEES defines hazardous substances emergency events as uncontrolled or illegal releases or threatened releases of hazardous substances. Events involving releases of only petroleum are not included. Events are included if (1) the amount of substance released (or that might have been released) needed (or would have needed) to be removed, cleaned up, or neutralized according to federal, state, or local law; or (2) the release of a substance was threatened, but the threat led to an action (for example, evacuation) that could have affected the health of employees, emergency responders, or members of the general public.

Various data sources were used to obtain information about these events. These sources included, but were not limited to, Missouri Department of Natural Resources (DNR), U.S. Coast Guard, National Response Center, DHSS Bioterrorism Surveillance, U.S. Department of Transportation Hazardous Materials Information System, Missouri State Highway Patrol, private companies, and Missouri Press Clipping Bureau (media). Census data were used to estimate the number of residents in the vicinity of the events. All data were computerized using a web-based data entry system provided by ATSDR.

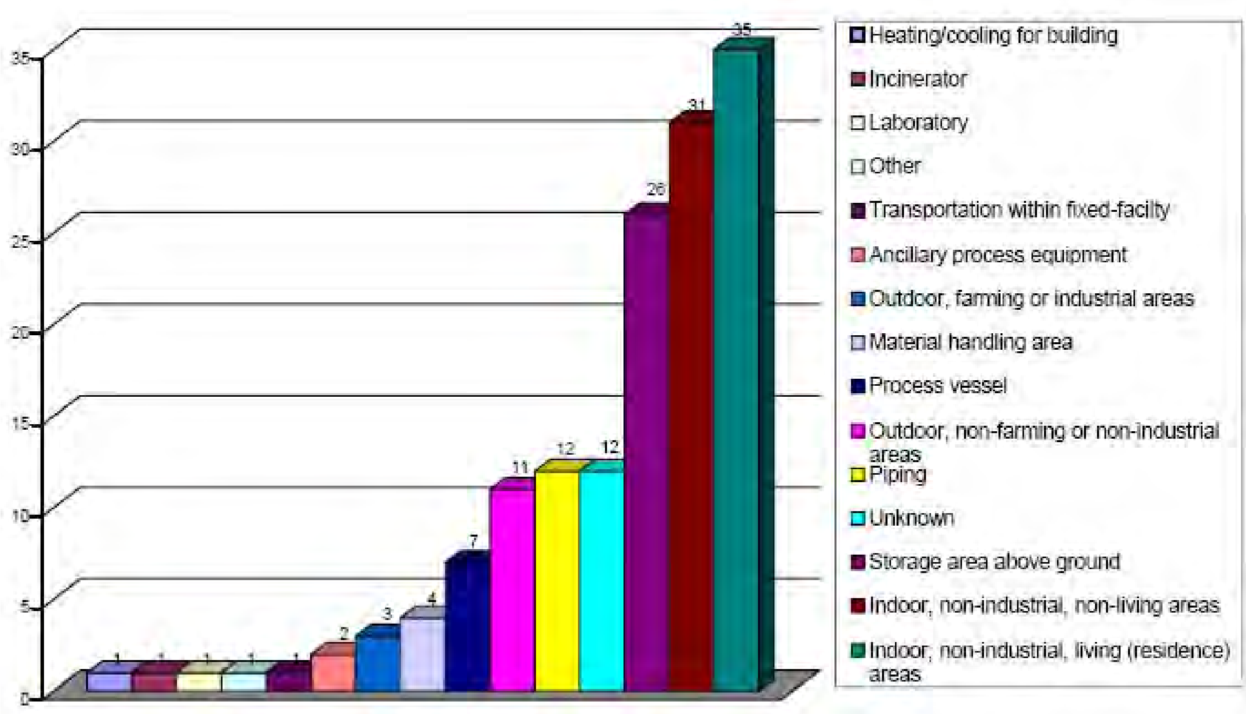
Historical Statistics

The DNR's Environmental Emergency Response (EER) Section receives most of the environmental emergency response reports in Missouri. All environmental emergencies may be reported, 24 hours a day, to (573) 634-2436. In fiscal year 2006, 2,493 reports were received by DNR/EER.

During 2004, a total of 300 events were reported to the Missouri Department of Health and Human Services. A total of 148 (49 percent) events occurred in fixed facilities. For each fixed-facility event, one or two types of area or equipment involved in the fixed facility where the event occurred could be selected. Of all 148 fixed-facility events, 134 (91 percent) reported one type of area and 2 (1 percent) reported a combination of two area types. Type of area was not reported for 12 (8 percent) events. Among events with one type of area reported, the main areas were classified as follows: 35 (26 percent) indoor, nonindustrial, living (residence) areas; 31 (23

percent) indoor, nonindustrial, nonliving areas; and 26 (19 percent) storage area above ground (i.e., warehouse, tank, storage shed) (See Figure 3.66).

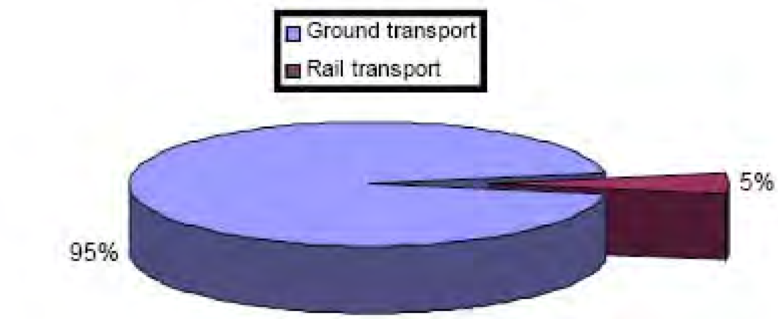
Figure 3.66. Areas of Fixed Facilities Involved in Events



Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System

Of the 152 transportation-related events, 144 (95 percent) occurred during ground transport (e.g., truck, van, automobile, or tractor) and 8 (5 percent) involved transport by rail (Figure 3.67). No events involved water, air, or pipeline transportation modes. Most (86 percent) ground transportation events involved trucks. The largest proportions of transportation-related events occurred during unloading of a stationary vehicle or vessel (65 [43 percent]) and from a moving vehicle or vessel (38 [25 percent]). Of the 152 transportation-related events, 33 (22 percent) involved a release en route that was later discovered at a fixed facility.

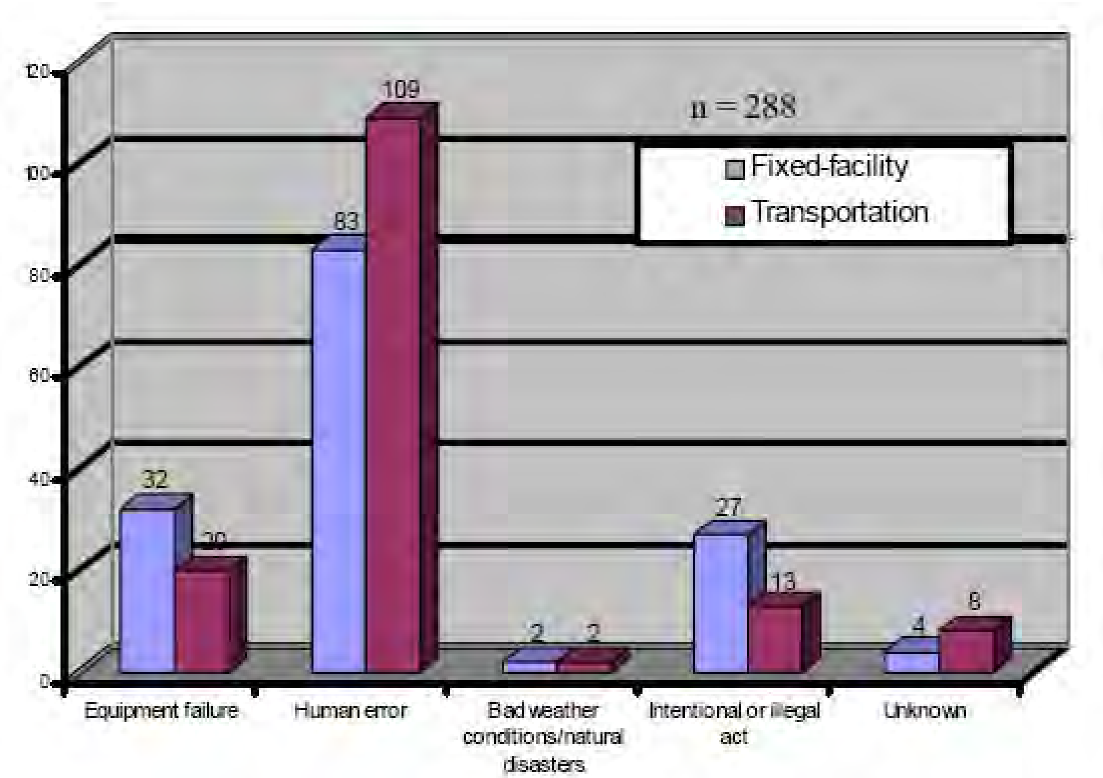
Figure 3.67. Distribution of Transportation-Related Events, by Type of Transport



Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System

Factors contributing to the events consisted of primary and secondary entries. Primary factors were reported for 288 (96 percent) events (Figure 3.68). Of the reported primary factors, most (29 percent) fixed facility and most (38 percent) transportation-related events involved human error.

Figure 3.68. Primary Factors Reported as Contributing to Events, by Event Type



Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System

Of the 299 events involving actual releases, 253 (85 percent) involved the release of one substance. Two substances were released in 12 (4 percent) of the events, and approximately 34

(11 percent) involved the release of more than two substances. Fixed-facility events were more likely than transportation events to have two or more substances released in an event (24 percent versus 7 percent).

In 253 (84 percent) events, only one substance was released. The most commonly reported categories of substances were other inorganic substances, volatile organic compounds, and acids. The individual substances most frequently released were ammonia, hydrochloric acid, mercury, and acetone (see Table 3.40). The substance categories most commonly released in fixed-facility events were other inorganic substances (54 [24 percent]), acids (38 [17 percent]), and volatile organic compounds (37 [16 percent]). In transportation-related events, the most common substance categories released were volatile organic compounds (35 [20 percent]), acids (25 [14 percent]), and other inorganic substances (25 [14 percent]).

Table 3.40. The 10 Most Frequent Substances Involved in Events

Number	Standardized Substance Name	Frequency
1	Ammonia	43
2	Hydrochloric Acid	26
3	Mercury	23
4	Acetone	20
5	Phosphorus	19
6	Sulfuric Acid	19
7	Sodium Hydroxide	15
8	Methamphetamine Chemicals NOS*	13
9	Ethyl Ether	11
10	Proteat	10
Total		**199**

Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System
Note:
*Not otherwise specified

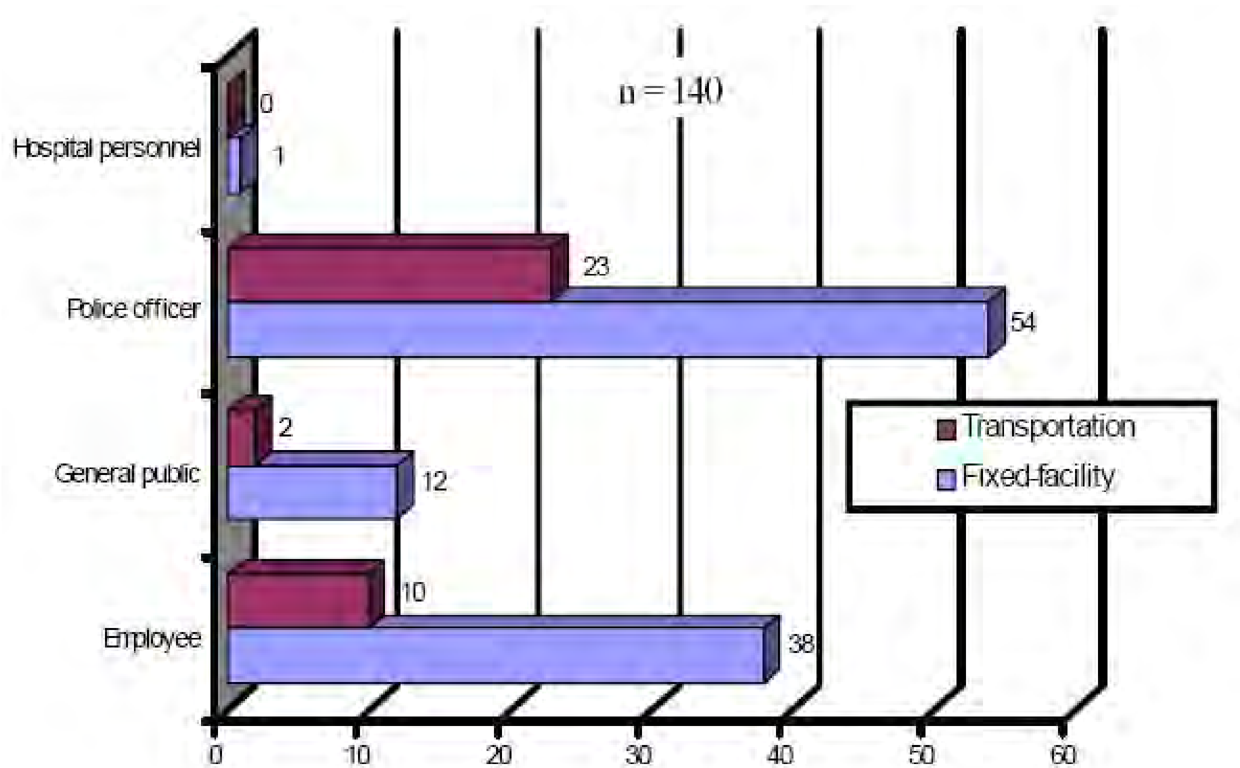
The number of events by month ranged from 14 (5 percent) in October to 39 (13 percent) in April, with the largest proportions occurring from March through May. The proportion of events ranged from 15 to 20 percent during weekdays and 6 percent during weekend days. Of all 278 (93 percent) events for which time of day or time category was reported, 30 percent occurred from 6:00 a.m. to 11:59 a.m., 28 percent from 12:00 p.m. to 5:59 p.m., 18 percent from 6:00 p.m. to 11:59 p.m., and the remainder during the early hours of the day.

A total of 140 victims were involved in 94 (31 percent) of the events. Of these 94 events, 73 (78 percent) involved only one victim, and 13 (14 percent) involved two victims. Of all victims, 105 (75 percent) were injured in fixed-facility events. Fixed-facility events were more likely to have three or more victims per event (6 percent) than were transportation-related events (2 percent).

Police officers (77 [55 percent]) constituted the largest proportion of the population groups injured, followed by employees (48 [34 percent]) (Figure 3.69). In fixed-facility events, 54

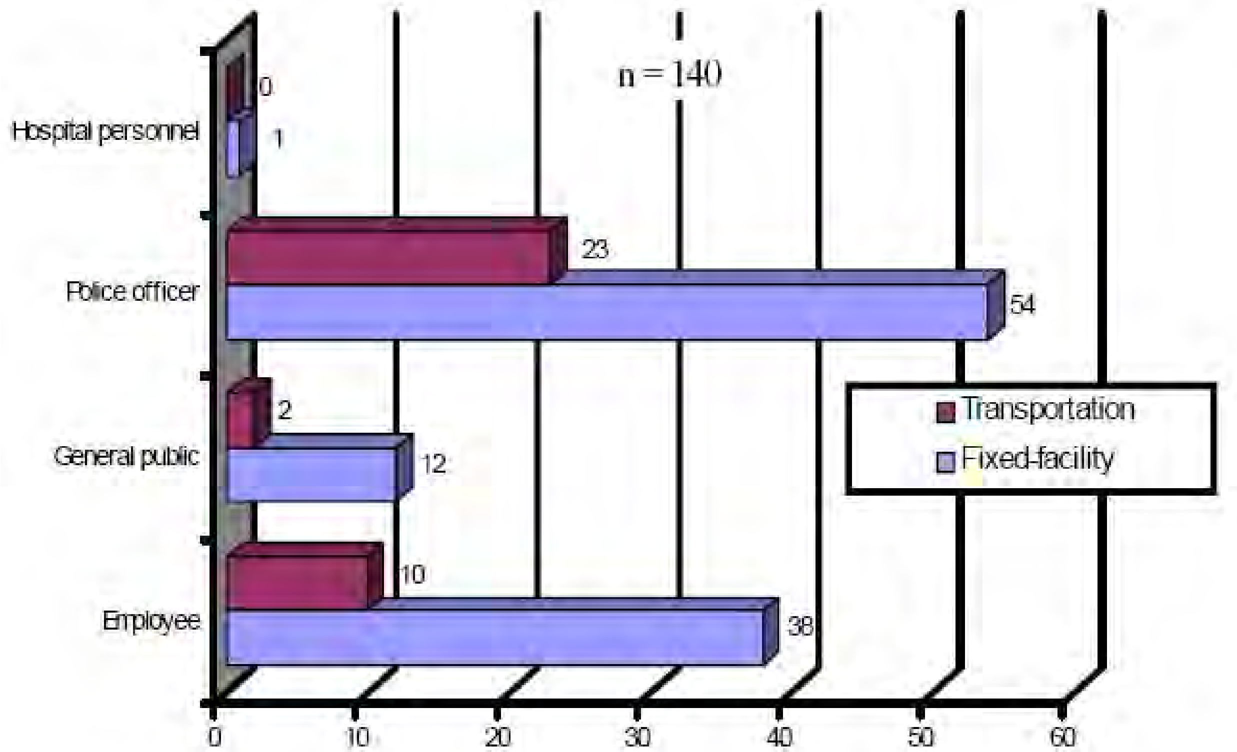
emergency response personnel were injured. All of those were police officers. Police officers were injured more frequently in fixed-facility events (70 percent) than in transportation-related events (30 percent) (Figure 3.70).

Figure 3.69. Number of Victims, by Population Group and Type of Event



Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System

Figure 3.70. Distribution of Responders Injured in Transportation-Related Events, by Type of Event



Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System

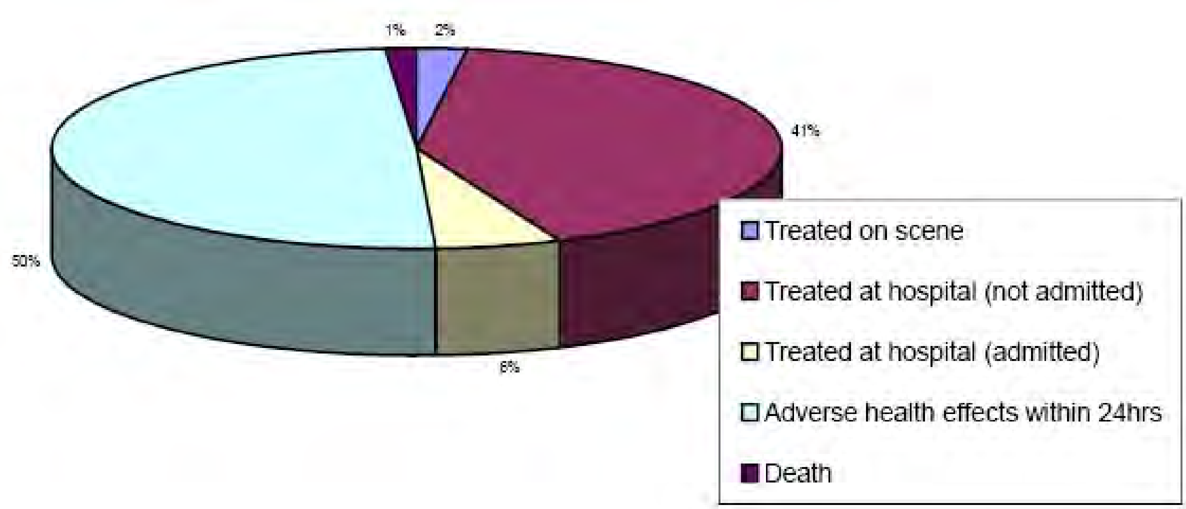
Victims were reported to sustain a total of 203 injuries or symptoms. Some victims had more than one injury or symptom. Of all reported injuries/symptoms, the most common injuries/ symptoms in fixed-facility events were respiratory irritation (61 [37 percent]), headache (42 [26 percent]), and dizziness/central nervous system symptoms (18 [11 percent]). In transportation-related events, headache (20 [53 percent]), trauma (7 [18 percent]), and respiratory irritation (6 [16 percent]) were reported most frequently. None of the trauma injuries in transportation-related events were substance-related; these injuries resulted from a chain of events, such as a motor vehicle accident leading to the release of a hazardous substance and not from exposure to the substance itself.

Of the 140 victims, 69 (50 percent) had adverse health effects within 24 hours and 58 (41 percent) were treated at a hospital (not admitted). Two (1 percent) deaths were reported (see Figure 3.71). There were no events in which the severity was unknown.

Only one event involved more than 10 injured people. Eleven employees were taken to the emergency room after coming in contact with chemical fumes. An aerosol can of brake parts cleaner and a duct liner adhesive, used to clean machinery, reacted together to cause a fume. The two different industrial chemicals were being used simultaneously and they produced a respiratory irritant. The employees were taken to a medical facility where they were

decontaminated and treated for respiratory problems, nausea, and dizziness. One employee fainted. Police, fire, emergency management personnel, and emergency medical personnel were called to the scene and the area was ventilated.

Figure 3.71. Injury Disposition

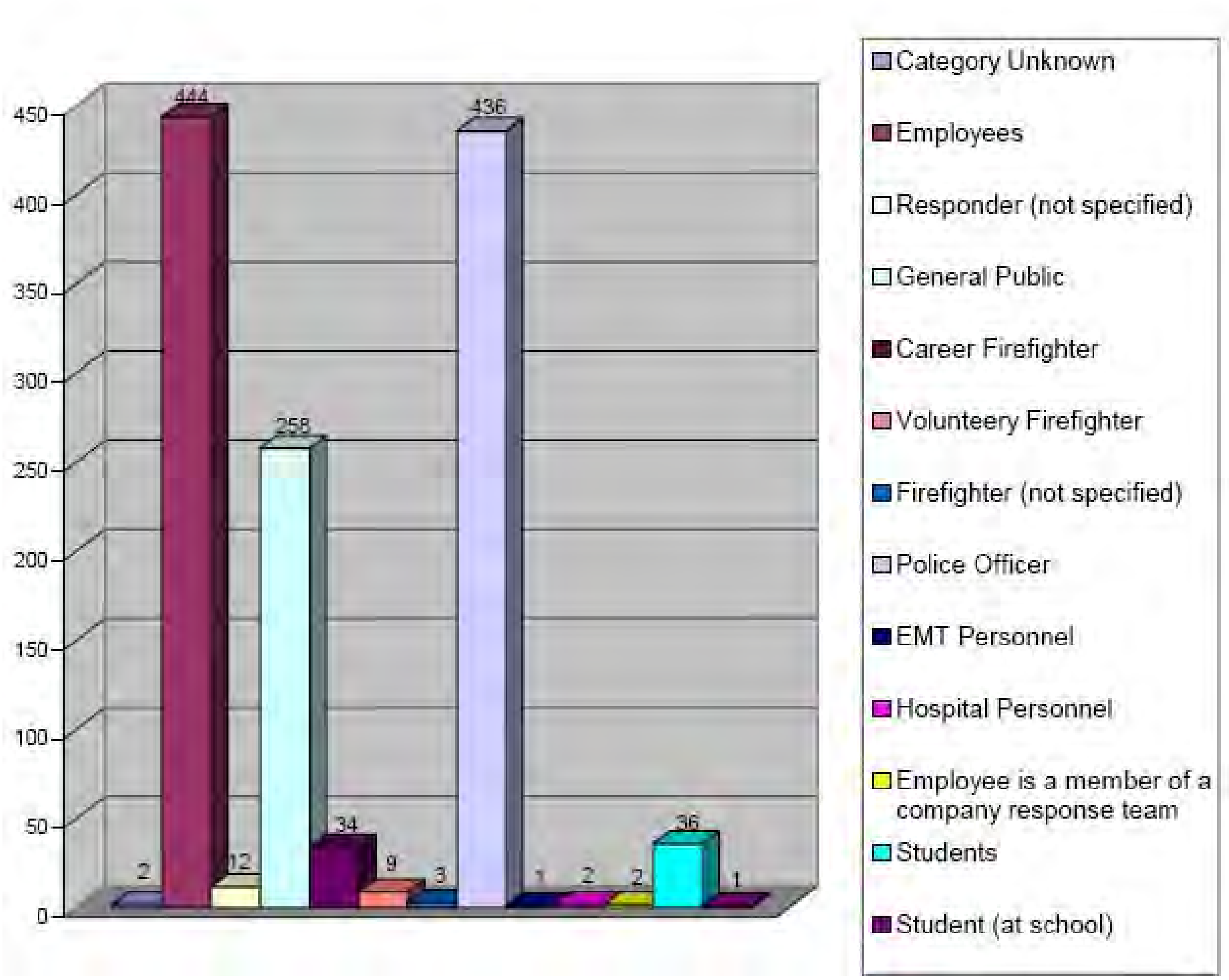


Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System

Respiratory irritation has consistently been the most frequently reported injury. Employees continue to be the most commonly reported victims of acute chemical releases. However, responders constitute a large proportion of the victims as well (Figure 3.72). The number of injured responders has decreased from 115 in 2002 to 77 in 2004. This decrease likely results from less police officers injured when responding to events involving the manufacture of methamphetamine. This may be a result of increased awareness and training for methamphetamine lab seizures among state and local law enforcement.

The number of deaths associated with acute hazardous substances events has decreased in recent years. Many of these deaths were attributed to nonchemical circumstances causing the events (e.g., a multiple vehicle accident resulting from high-speed travel of a truck pulling an ammonia tank).

Figure 3.72. Number of Victims, by Category and Year

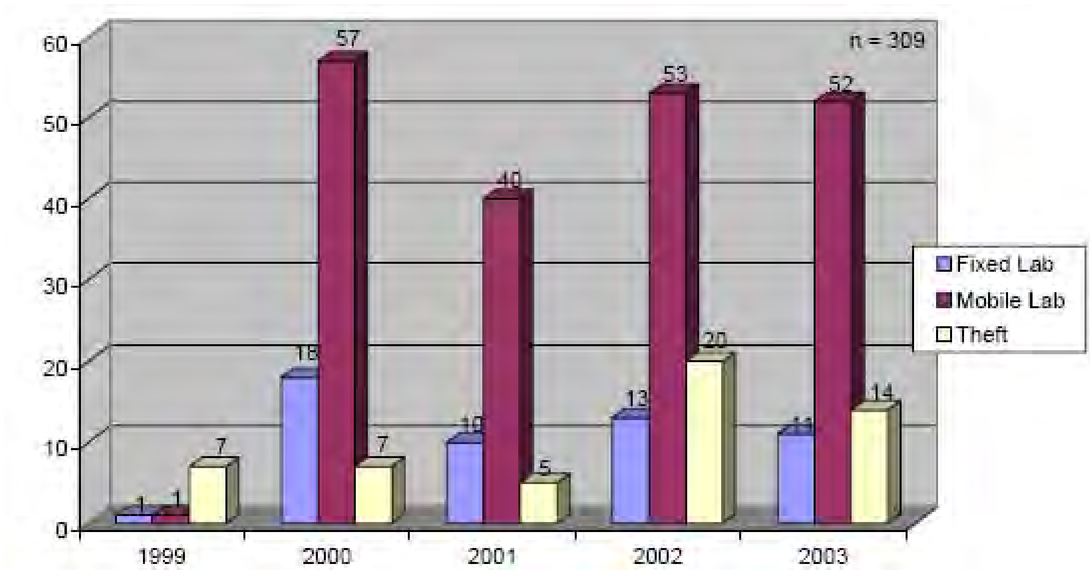


Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System

Between 1999 and 2003, local, state, and federal officials reported 9,160 seizures of methamphetamine labs, dumpsites, and locations of inactive labs in Missouri—more than any other state in the nation.

Missouri reported a total of 309 HSEES events related to methamphetamine for between 1999 and 2003. The largest proportion of events occurred in fixed facilities. Each methamphetamine event was categorized into the type of situation such as theft, fixed-lab (private residence, abandoned lab), and mobile lab. There were 203 (66 percent) fixed labs, 53 (17 percent) mobile labs, and 53 (17 percent) events in which chemicals were stolen from an agricultural facility (Figure 3.73).

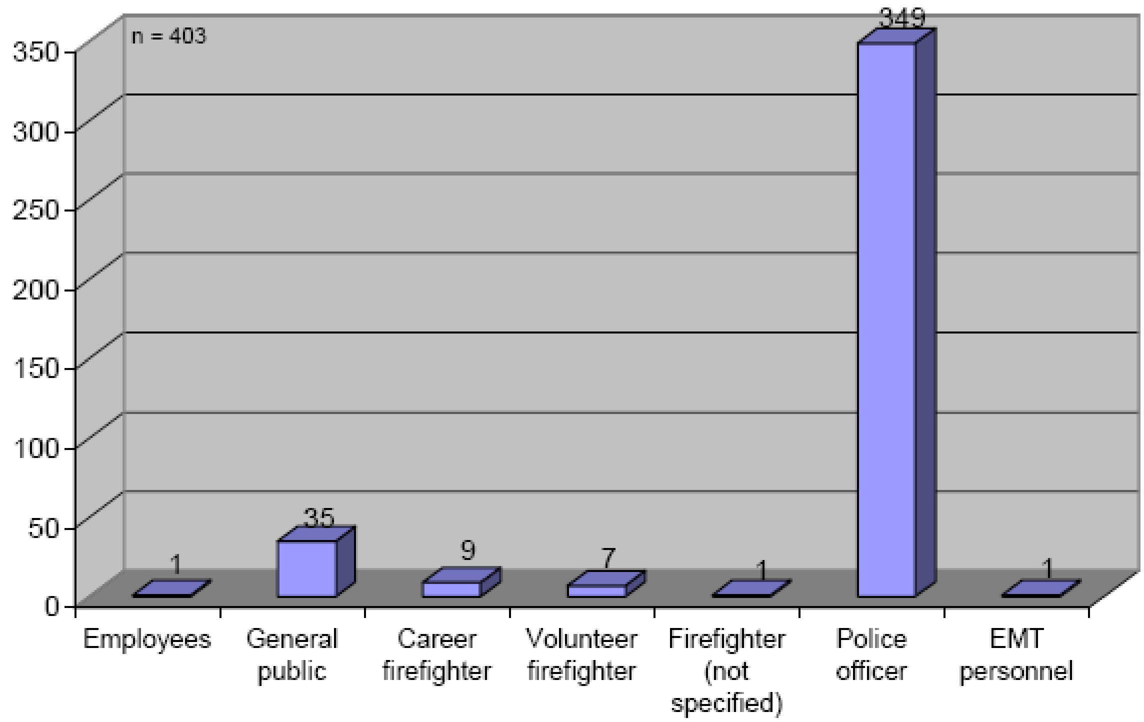
Figure 3.73. Methamphetamine Related-Events Situation, by Year



Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System

In the 254 methamphetamine events involving injuries, respiratory symptoms consistently have been most frequently reported. The number of deaths associated with events continues to suggest the need to evaluate not only the danger posed by methamphetamine substances, but also the circumstances surrounding the events (e.g., insufficient personal protection against adverse health effects). Police officers continue to be the most commonly reported victims of methamphetamine emergency events (Figure 3.74).

Figure 3.74. Number of Methamphetamine-Related Victims, by Victim Category



Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System

Between 1994 and 2004, the largest proportion of events occurred in fixed facilities (see Table 3.41). The number of reported transportation-related events increased from 1998 to 2003, and then decreased in 2004. The decrease is partially due to fewer reports from the U.S. Department of Transportation's Hazardous Materials Information System. The number of substances released has been inconsistent over the years and continues to fluctuate. The percentage of events with victims was highest in 2002 (32 percent) and lowest in 1995 (3 percent). The average percentage of events with victims between 1994 and 2004 was 17 percent.

Table 3.41. Cumulative Data, by Year*

Year	Type of Event		Total	No. Substances Released	No. Victims	No. Deaths	Events with victims	
	Fixed Facility	Transportation					No.	%**
1994	137	67	204	231	32	1	15	7%
1995	172	156	328	360	13	1	9	3%
1996	109	51	160	175	59	2	12	8%
1997	113	70	183	216	23	1	13	7%
1998	145	51	196	197	24	2	17	9%
1999	166	125	291	312	71	3	23	8%
2000	199	162	361	486	197	14	103	29%
2001	145	160	305	369	157	3	79	26%
2002	201	193	394	501	307	5	127	32%
2003	225	205	430	575	217	3	135	31%
2004	148	152	300	403	140	2	94	31%
Total	**1,760**	**1,392**	**3,152**	**3,825**	**1,240**	**37**	**627**	20%

Source: Missouri Department of Health and Senior Services Hazardous Substances Emergency Events Surveillance System
*Numbers in the table may differ from those reported in previous years because of adjustments in HSEES qualification requirements for events.
**Percentage of events with victims.

Measure of Probability and Severity

Fixed Facility Accidents

Probability: Moderate
Severity: Moderate

Transportation Accidents

Probability: High
Severity: Moderate

Note: While there have been more documented fixed facility accidents, the probability is ranked greater for transportation accidents due to the potential for more incidents to occur, but inability to predict exactly where these incidents will occur. The severity to the environment will vary in every case depending on the amount, type, and method of release. Close coordination between the Missouri Department of Natural Resources, the U.S. Environmental Protection Agency (EPA), the local jurisdiction, and the spiller (responsible party) is required to ensure that potential impacts to public health and the environment are adequately addressed.

Hazardous Materials Fixed-Facility Accident

The probability of occurrence is rated as moderate. With the new regulations from EPA and the Occupational Health and Safety Administration, along with more stringent state laws and employee awareness training, this rating may be lowered to low or raised to high based on past performance. This rating means the probability of occurrence is possible during the expected lifetime of the facility.

The severity of consequences is rated as moderate but may be either low or high depending on the type and amount of chemical released. This means the chemical is expected to move into the surrounding environment at a concentration sufficient to cause serious injuries and/or death, unless prompt and effective corrective actions are taken. Injuries and/or death would be expected only for personnel exposed over an extended period or when individual personal health conditions create complications.

Hazardous Materials Transportation Accident

The probability of occurrence is rated as high because of the large volume of hazardous materials being hauled over the highways and railways. This rating means that the probability of occurrence is considered sufficiently high as to assume that an event will occur at least once within any mode of transportation (including water, pipeline, and air) during a three-year HSEES reporting period.

The severity of the consequences is rated as moderate, but may be either low or high depending on the location of the accident and the time of day. This rating means injuries and/or death are expected only for exposed personnel over extended periods of time or when individual personal health conditions create complications.

Impact of the Hazard

The entire State of Missouri is susceptible to this type of hazard, depending on a number of factors such as the type of chemical, amount released/spilled, method of release, location of release, time of day, and weather conditions.

This hazard could have a significant impact on the public health, the environment, private property, and the economy.

The impact of this type of disaster will likely be localized to the immediate area surrounding the incident. The initial concern will be for people, then the environment. If contamination occurs, the spiller is responsible for the cleanup actions and will work closely with the Missouri Department of Natural Resources, EPA, and the local jurisdiction to ensure that cleanup is done safely and in accordance with federal and state laws.

Local government (county or municipal) is more often directly impacted by radiological incidents than state or federal government. Local responders are generally the first on scene for

any incident. Therefore, they have the responsibility for treating any injured victims and transporting them to a hospital for more complete medical care. Also, local first responders have the initial responsibility for controlling exposure of emergency workers and the public to any radioactive materials and to contain the spread of radioactive contamination as much as possible. While cleanup of any actual spill of radioactive materials rests with the shipper (in most cases), local responders may be required to provide site control for several hours until the responsible parties arrive on the scene.

A past survey was completed of Missouri fire departments across the state, asking their perception of their own capabilities to respond to a radiological incident. Of the 433 departments surveyed, only 118 responded. Of those, 21 believed they could adequately handle a radiological incident until proper authorities arrive.

This indicates that pockets of adequate radiological response capabilities are available throughout the state. However, the main transportation corridors have some gaps. It is also clear that more training needs to be encouraged along these corridors. The same consideration must be given to any county located under commercial flyways or where it might be possible for a fallen satellite to leave a contaminated “footprint” (COSMOS 954 left a 200-mile footprint in the Northwest Territory of Canada in 1978).

The information in Table 3.42 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.42. EMAP Impact Analysis: Hazardous Materials

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be severe for plume area and moderate to light for other adversely affected areas.
Health and Safety of Personnel Responding to the Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the plume area of the incident, possibly for extended period.
Delivery of Services	Localized disruption of roads and/or utilities may postpone delivery of some services.
The Environment	Localized impact expected to be severe for plume area. Remediation required.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time, depending on damage, extent of cleanup, and length of investigation.
Regulatory and Contractual Obligations	Regulatory requirements must be fulfilled. Fulfillment of some contracts may be difficult. Impact may reduce deliveries.
Reputation of or Confidence in the Entity	Localized impact expected to primarily adversely affect HazMat source owner and local entities.

Synopsis

Any disaster or emergency incident, such as an earthquake or a flood, could result in additional concerns when it involves hazardous materials. For example, during the floods of 1993, a large propane tank farm in St. Louis was threatened by rising floodwaters, forcing evacuations of nearby residents in several areas. Another hazardous materials incident related to the 1993 floods involved an on-going ammonia release from the La Roche Industries, Inc., facility near Crystal City, Missouri, caused by power failure and failure of the cooling system on a large ammonia tank, which ultimately resulted in off-gassing of ammonia through the tank's pressure relief check valves. The ammonia cloud over the plant led to a declaration of restricted air space in the plant vicinity for several days.

In addition, thousands of chemical containers ranging from household products and 55-gallon drums to 10,000-gallon fuel storage tanks were displaced statewide as a result of the flood

damage. A federal disaster declaration was issued, the Federal Response Plan (FRP) was implemented, and Emergency Support Function #10—Hazardous Materials Annex was activated to support the statewide response to hazardous materials incidents like these and others that resulted from the flooding.

Each emergency event will need to be evaluated on an incident-specific basis, and top priority must be given to the protection of the public, then the environment, and ly property.

Tier II Forms are filed and maintained by the Missouri Emergency Response Commission at SEMA. Site-specific plans are on file with each county's local emergency planning commission. Transportation and evacuation routes are addressed in each county emergency operations plan. See Figure 3.83 in Section 3.2.18 Utilities for the natural gas pipeline map. The SEMA Homeland Security Response Teams Map, included in Section 3.2.17 Terrorism, indicates 28 existing or proposed Homeland Security Response Teams for Missouri. A few of these teams include hazardous materials response teams with enhanced capabilities for response to weapons of mass destruction incidents, including incidents involving nuclear or radiological materials, biological agents, and chemical agents. The SEMA Terrorism Program should be contacted to determine the capabilities of these Homeland Security Response Teams in specific areas.

3.2.13 Mass Transportation Accidents

Description of Hazard

For the purpose of this study, mass transportation is defined as the means, or system, that transfers large groups of individuals from one place to another. This profile addresses only transportation accidents involving people, not materials. Thus, mass transportation accidents include public airlines, railroad passenger cars, metro rail travel, tour buses, city bus lines, school buses, riverboat casinos, and other means of public transportation.

Missouri serves as a transportation crossroad for the United States. Missouri, being centrally located in the nation, is a natural hub for many major airlines and other types of tourist and business travel. Many cross-country travelers use Missouri terminals to connect with transport changes. The state's airways, railways, and highways are used as nonstop thoroughfares as well.

In 1993, Missouri's largest city, St. Louis, began operating a MetroLink rail transportation system. Before service began, ridership was projected at 12,000 per day. In August 1993, during the system's first month of operation, between 20,000 and 35,000 rode the MetroLink each day. In July 1994, the average weekday ridership topped 42,000. The MetroLink carried nearly 9 million customers during its first year of operation. During 1997 and 1998, 54.2 million residents rode public transportation, with MetroLink ridership continuing to grow, averaging 44,500 per day. During Independence Day celebrations on July 4, 1999, the MetroLink moved 160,833 passengers. Normally, the largest numbers of people are transported during the morning and evening rush hours.

Amtrak, the state’s major passenger rail carrier, uses tracks that cross the entire state from east to west. Although Amtrak has experienced a decline in passengers during this decade, it continues to carry a large number of passengers daily. The peak periods are related to holidays or special events.

Branson, Missouri, which is located close to the state’s southwestern border, has become one of this state’s major tourist attractions. It ranks high among the nation’s top attractions. Because Branson is a small community, tourists are more visible there than in Kansas City and St. Louis. The city has been expanding its services (number of hospital beds, fire equipment, ambulances) and is able to provide more assistance than other small communities in the state.

Tour bus travel in the state is on the increase. With Branson continuing to expand, more bus traffic can be expected. The Passenger Carrier Inspection Division of the Missouri Department of Transportation has developed a comprehensive passenger carrier safety inspection program. Passenger carrier safety is a primary concern for the division because Missouri, and especially Branson, is among the top tourist destinations in North America. Division inspectors conduct safety inspections at destinations or carrier terminals when buses do not have passengers on board.

The threat of a terrorist attack on any mass transit system is real in Missouri. On July 7, 2005, there were four explosions in the London Underground during morning rush hour: first hit was a commuter train in London’s financial district that killed 7; second hit was a commuter train at King’s Cross Station that killed 21; third hit was a commuter train west of King’s Cross that killed 5 people; and fourth hit was a double-decker tourist bus near King’s Cross Station. Scotland Yard determined that Islamic extremists were the suicide bombers. This attack exemplifies the hazard that exists for any mass transportation system in the world.

The division has two classifications of passenger carriers: for-hire and private. For-hire passenger carriers provide service to the general public and are required to register with the division. Private carriers provide passenger service in furtherance of a commercial enterprise. Examples include, but are not limited to, hotel courtesy buses, airport passenger shuttle services, buses operated by professional musicians, and buses for civic and other groups such as scout groups where no fees are collected.

The definition of a passenger carrier varies somewhat depending on whether the operation is entirely intrastate or interstate. The Federal Highway Administration’s Office of Motor Carriers defines interstate passenger carrier as any vehicle designed to transport more than eight passengers, including the driver, across state boundaries. The administration defines an intrastate passenger carrier as any vehicle (not operated as a taxi or otherwise exempt) designed to transport more than six passengers, including the driver, within the state.

Historical Statistics

Commercial motor vehicles have been involved in a significant number of Missouri traffic accidents. Statistics from the Missouri State Highway Patrol Statistical Analysis Center show that in 2005 10.3 percent of all traffic accidents involved a commercial motor vehicle. Of fatal traffic accidents, 16.2 percent involved a commercial motor vehicle. A total of 214 persons were killed and 5,728 were injured in commercial motor vehicle-related accidents in 2005. Commercial motor vehicles are defined as trucks having six or more tires on the power unit, buses or school buses having occupant capacities of 16 or more, and vehicles displaying hazardous materials placards. In 2005, accidents involving buses and school buses resulted in six fatalities.

Table 3.43 shows 2001–2003 nationwide statistics of fatality rates by mode of travel.

Table 3.43. Fatality Rates by Mode of Travel, 2001–2003 (Average Deaths per 100 Million Passenger Miles) Highway Vehicle Occupants and Transit Passengers

Type of Vehicle	Death Rate
Airlines	0.02
Automobiles	.77
Vans, SUVs, Pickup Trucks	.76
Heavy, Light, and Other Rail Vehicles	Not reported
Intercity and Commuter Railroads	0.03
Intercity Buses	0.02
Transit Buses	0.03

Source: Injury Facts, National Safety Council, 2005-2006

Measure of Probability and Severity

Probability: Moderate
Severity: Moderate

A major accident can occur at any time, even though all safety precautions are in place. Based on the latest available information, the probability and severity of a mass transportation accident are both rated as moderate.

Impact of the Hazard

A mass transportation accident, which could include those involving buses, could burden a local jurisdiction's available medical services. To minimize this problem, mutual aid agreements with adjoining jurisdictions should be developed between ambulance services and the hospitals. This type of hazard could involve hazardous materials or a fire, which would compound the impacts of the incident. Severe weather could also hamper response efforts.

The information in Table 3.44 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.44. EMAP Impact Analysis: Mass Transportation Accident

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be severe for incident area and moderate to light for other adversely affected areas.
Health and Safety of Personnel Responding to the Incident	Adverse impact expected to be moderate to light for trained, equipped, and protected personnel.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the area of the incident. Some severe damage possible.
Delivery of Services	Localized disruption of roads and/or utilities caused by incident may postpone delivery of some services.
The Environment	Localized impact expected to be severe for incident areas and moderate to light for other areas affected by smoke or HazMat remediation.
Economic and Financial Condition	Local economy and finances may be adversely affected, depending on damage and length of investigation.
Regulatory and Contractual Obligations	Regulatory waivers may be needed locally. Fulfillment of some contracts may be difficult. Impact may temporarily reduce deliveries.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

Missouri serves as a transportation crossroads for the United States. Branson, Missouri, which is located close to the state’s southwestern border, has become a major tourist attraction. Because Branson is a small community, tourists represent a large portion of the population. To meet the needs posed by the large number of tourists, the city has been expanding its services (number of hospital beds, fire equipment, ambulances, etc.) and is able to provide more assistance than other communities of its size. A mass transportation accident could burden a local jurisdiction’s available medical services. To minimize this problem, mutual aid agreements should be developed between ambulance services and hospitals of adjoining jurisdictions. The risk of this type of incident is moderate.

For additional information, see the “2005 Missouri Traffic Safety Compendium,” available from the Statistical Analysis Center of the Missouri State Highway Patrol, a division of Public Safety.

3.2.14 Nuclear Power Plants (Emergencies and Accidents)

Description of Hazard

There are presently four fixed nuclear facilities or reactors that, under extreme circumstances and conditions, could pose a threat to citizens of Missouri. These four reactors fall into two categories: research reactors and commercial nuclear power reactors. The first category, research reactors, represents a hazard only to personnel or others on-site at the facility. Therefore, these reactors are not included in state radiological plans involving off-site emergency preparedness. For the second category, commercial nuclear power reactors, a worst-case scenario involving a significant release of radioactive material could force the evacuation of the general population within a 10-mile radius of the facility. A release of this magnitude could also contaminate food and water sources within a 50-mile radius.

The magnitude of releases from nuclear plant sites varies depending on the nature of the accident type, reactor design, and meteorological conditions during the release. The Nuclear Regulatory Commission and FEMA have developed regulatory guidance that both the state and utility must meet to protect the health and safety of the general population within the 10-mile emergency planning zone (EPZ). Four classes of emergency action levels are used for early notification of incidents, with clear instructions for emergency organizations within the EPZ. The four emergency classifications listed in progression of severity are notification of unusual event, alert, site area emergency, and general emergency. These levels are discussed below.

- **Notification of Unusual Event—**This classification describes unusual events that are in process or have occurred and indicates a potential degradation of the safety level of the plant. No releases of radioactive material requiring off-site response or monitoring are expected unless safety systems are further degraded.
- **Alert—**This classification describes unusual events that are in process or have occurred and indicate a potential degradation of the level of plant safety. Any releases are expected to be limited to small fractions of the U.S. Environmental Protection Agency (EPA) Protective Action Guideline (PAG) exposure levels.
- **Site Area Emergency—**This classification level describes events in process or having occurred that involve actual or likely major failures of the plant functions needed to protect the public. No releases are expected to exceed EPA PAG exposure levels except near the site boundary.
- **General Emergency—**This classification describes an event in process or having occurred that involves actual or imminent substantial core degradation or melting, with the potential for loss of containment integrity. Releases can reasonably be expected to exceed the EPA PAG exposure levels off-site for more than the immediate site area.

Historical Statistics

Research Reactors

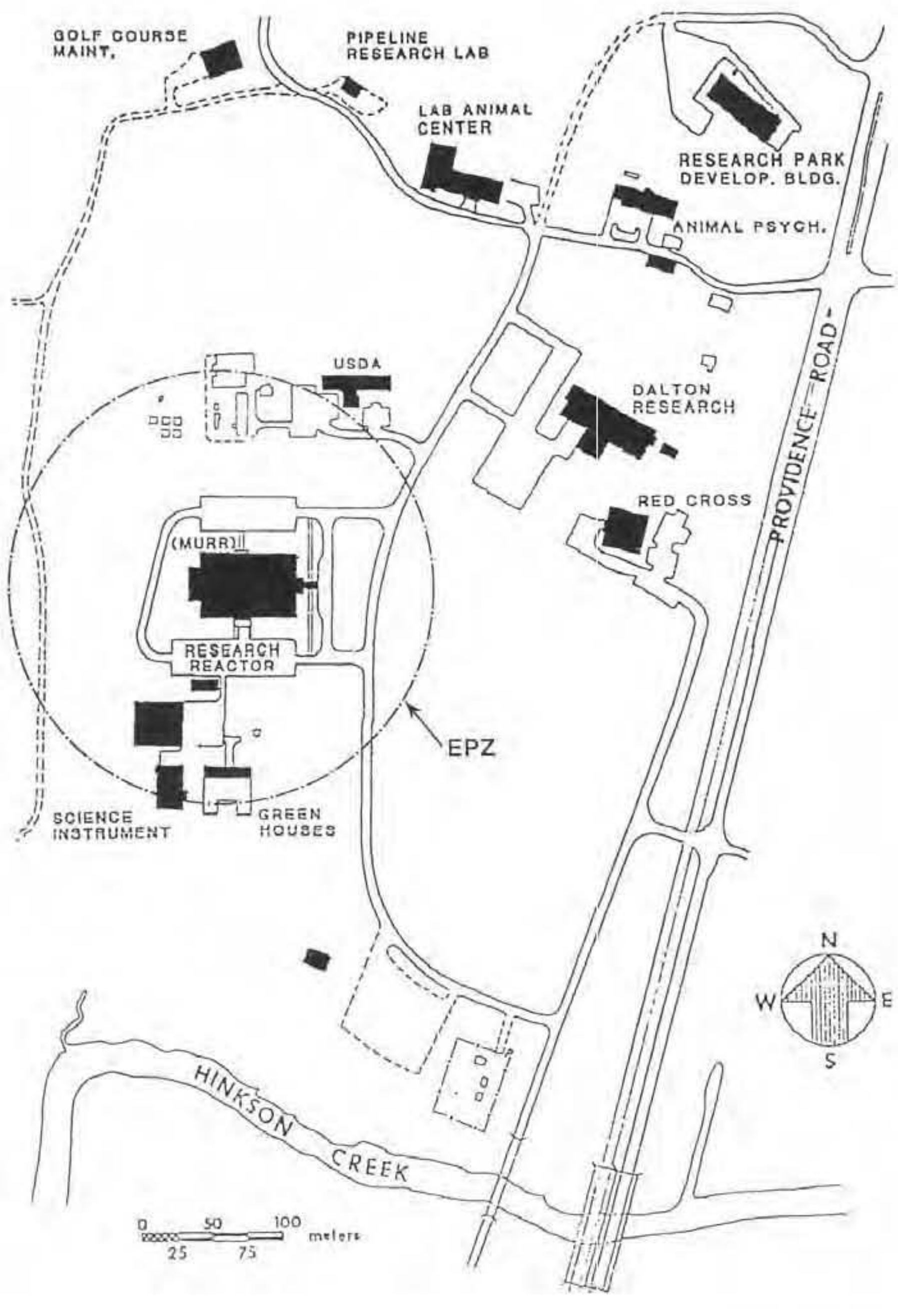
Two research reactors are located in Missouri: the University of Missouri–Rolla Reactor (UMRR) and the University of Missouri–Columbia Research Reactor (MURR). The maximum hypothetical accident from either research reactor would place at risk only personnel working at the facilities or the public within the site boundary of the respective facilities. Both research reactors have emergency plans approved by the Nuclear Regulatory Commission (NRC) that conform with regulatory requirements in 10 CFR 50, Appendix E, and follow the guidance provided by Revision I to NRC Regulatory Guide 2.6, Emergency Planning for Research and Test Reactors, March 1982, and ANSI/ANS-15.16, Emergency Planning for Research and Test Research Reactors, November 29, 1981.

The UMRR is a water-moderated pool-type reactor licensed to operate at 200 kilowatts. The UMRR is used for training and research purposes. Because the reactor is mainly used for training, it is not operated for long periods of time. The reactor is located on the east side of the Rolla campus near 14th Street and Pine Street in Rolla, Missouri. Due to the low power of licensing (200 kilowatts), prevailing standards and guidelines do not require the establishment of an emergency planning zone. Therefore, no classification higher than a “site area emergency” has been included in the UMRR emergency plans. The UMRR has been in operation since December 1961 and has never had an incident that would be considered an emergency action level.

The MURR is a 10 megawatts pressurized water-moderated pool-type reactor with a containment building. The MURR is used to provide research, training, and services to the four campuses of the University of Missouri system as well as other universities, government agencies, and private industry. The reactor is located on a 550-acre tract of land south of the University of Missouri–Columbia campus on Providence Road. The MURR has an emergency planning zone encompassing the area within a 100-meter radius from the exhaust stack (see Figure 3.75). No credible potential accidents have been identified for the MURR facility that would result in exceeding the classification of “notification of unusual events.” As a result, no classification higher than a “site area emergency” is included in the emergency plan for the MURR.

The MURR has been in operation since October 1967. The reactor averages 8,060 hours of operation per year (155 hours per week) at peak flux due to the service work that it performs. During its history of operation, the MURR has never had an incident that would be considered an emergency action level.

Figure 3.75. Emergency Planning Zone for MURR



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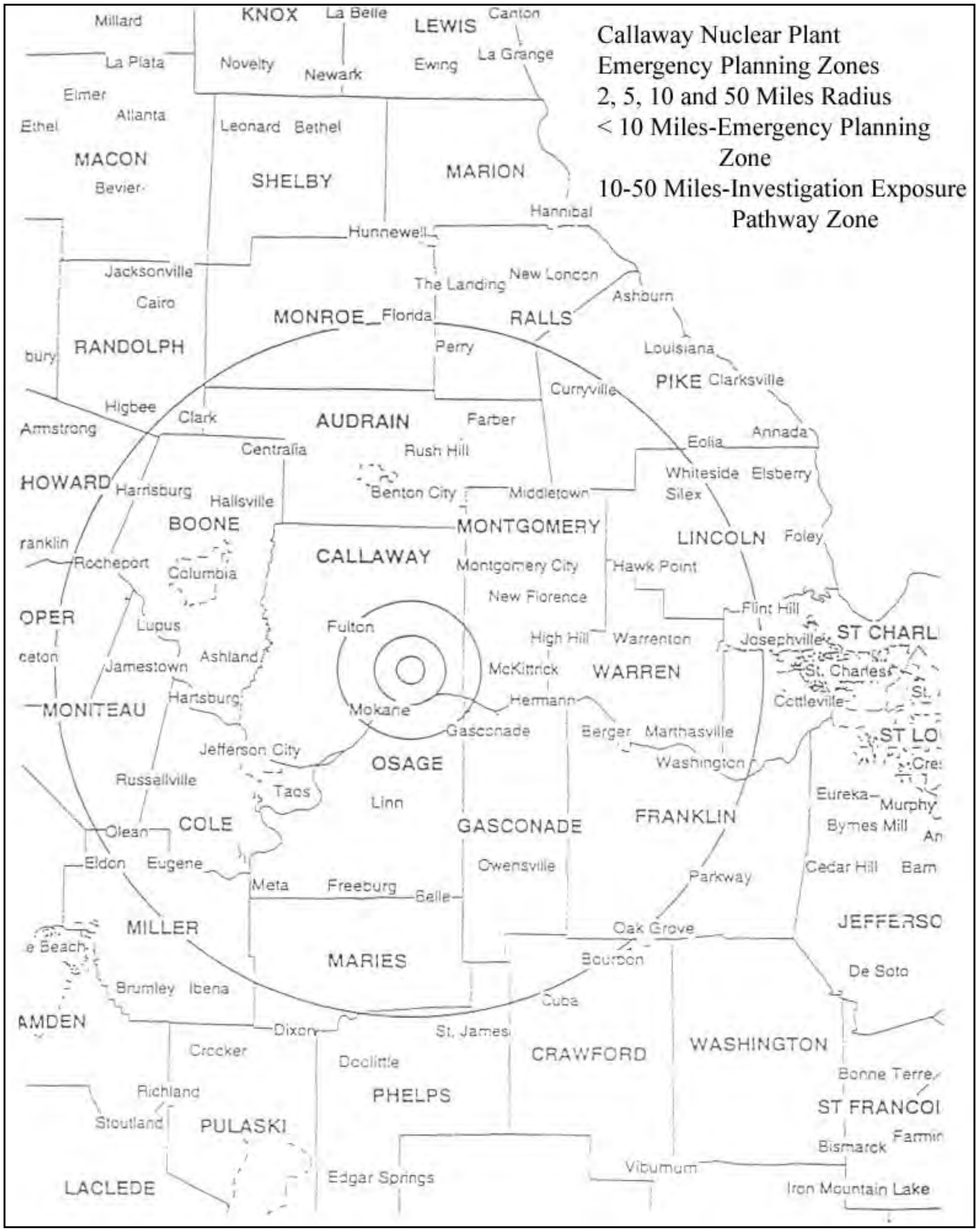
Commercial Nuclear Power Reactors

Two commercial nuclear power reactors could have an impact on the health and safety of Missouri citizens. These reactors are the Callaway Nuclear Plant and the Cooper Nuclear Station, both of which are used for electrical power generation. Both utilities have emergency plans that conform to NUREG-0654, FEMA-REP-1 Rev.1, Criteria for Preparation and Evaluation of

Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants. The utilities and the state are required to demonstrate annually various elements of preparedness through radiological emergency drills evaluated by inspectors representing FEMA and the NRC.

The Callaway Plant consists of one unit with a pressurized water reactor capable of providing 1150 megawatts of electricity. The plant is located in Callaway County, Missouri, and is owned and operated by AmerenUE, St. Louis. It is located 10 miles southwest of Fulton, 25 miles northeast of Jefferson City, 5 miles north of the Missouri River, and 80 miles west of St. Louis. The population within the 2.5 mile radius of the plant is low (approximately 30 residents). Approximately 4,500 people reside within a 10-mile radius of the plant. The plume exposure pathway has been expanded beyond the 10-mile radius to include the City of Fulton (population 12,128). Thus, the population within the plume exposure pathway is approximately 16,000. The plant site consists of 7,200 acres of land at the site, 6,800 of which are administered by the Missouri Department of Conservation as the Reform Conservation Area. Under this program, part of the area continues to be farmed, with income from farming providing funds for wildlife management and public recreation activities. Land within a five-mile radius of the plant site is rural, consisting of 60 percent forest, 20 percent farm/crop land, and 20 percent pasture. Figure 3.76 illustrates the emergency planning zone for the Callaway Nuclear Power Plant.

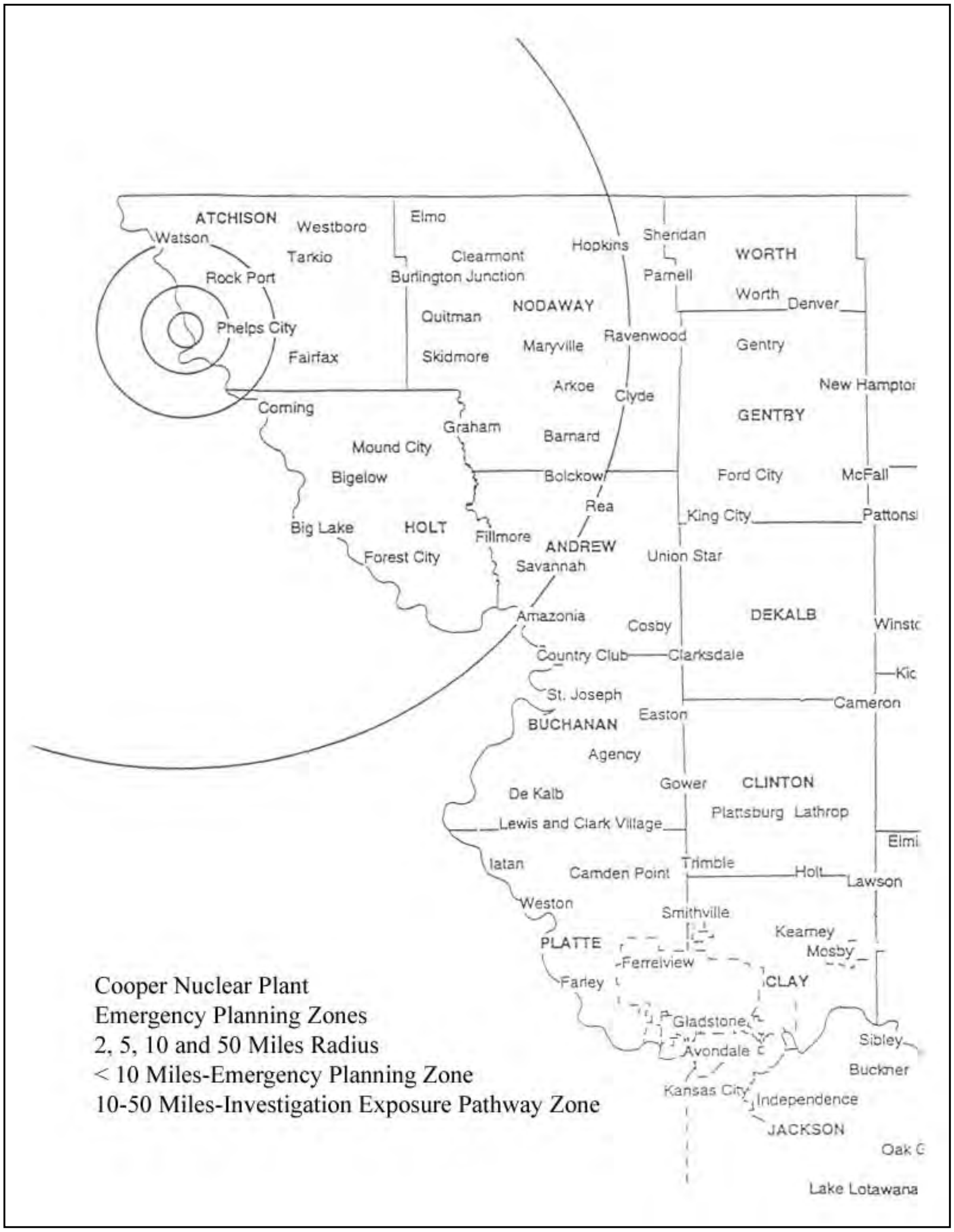
Figure 3.76. Emergency Planning Zone for Callaway Nuclear Power Plant



The Cooper Nuclear Station is a direct-cycle boiling water-type reactor with a net electrical generating capacity of 800,000 kilowatts. The facility is owned by the Nebraska Public Power District of Columbus, Nebraska. The plant is located on the Nebraska side of the Missouri River in Brownville, Nebraska, approximately seven miles southwest of Rock Port, Missouri. The emergency planning zone within the Missouri side of the river is predominantly rural land, except for the towns of Rock Port, population 1,395, Phelps City, population 39, Langdon, population 32, and Watson, population 121. Atchison County is primarily affected by the emergency planning zone (see Figure 3.77) and is intersected by several major highways,

including Interstate 29, U.S. Highway 136, U.S. Highway 275, and Missouri Highway 111. The total population at risk from a radiological incident in Atchison County is as follows: within 2 miles, approximately 15 people; within 5 miles, approximately 246 people; and within 10 miles, approximately 2,660 people.

Figure 3.77. Emergency Planning Zone for Cooper Nuclear Station



Measure of Probability and Severity

Probability: Low
Severity: Moderate

The consequences of a radiological incident originating from one of the commercial nuclear power plants affecting the state can range in severity from insignificant to a high degree of radioactive contamination within the 2- to 10-mile radius surrounding the facility. The most crucial concerns during a severe incident are safe evacuation and controlled access to the areas affected by a release of radioactive materials. In the aftermath, the main concerns are as follows: the extent of property needing to be decontaminated, contaminated food sources, and the time required to reach acceptable exposure rates and to allow the safe reentry of the public. Historically, due to their safe operation records, fixed nuclear facilities have not represented a high risk to the state. The Reactor Safety Study conducted by the NRC rated the chances of a major nuclear disaster as very low (a probability of one in one million per plant operating year). The report concluded that the worst accident type that could affect a nuclear power plant would be one resulting in a meltdown, which could be expected to occur once in 20,000 years of reactor operation. The report also stated that a meltdown would likely cause less than one fatality or injury. This low hazard rating is due to all of the added safety engineered instrumentation used to monitor and shut down nuclear plant systems before any severe damage occurs.

Impact of the Hazard

An incident at a nuclear power plant resulting in a “general emergency” and evacuation (one where a release from the site boundary would be expected) could have a dramatic psychological impact on the uninformed population within the evacuation zone. The utilities and the state have an active Radiological Emergency Preparedness program to prepare local jurisdictions and the general population surrounding the plant for responding to such an incident. This program includes in-depth training of resources both from the state and local jurisdictions, and regularly scheduled drills and exercises evaluated by FEMA. Extensive planning has focused on implementation of the emergency response plan for both the state and local jurisdictions. Emphasis is placed on prompt notification of emergency organizations and the public; evacuation routes; reception and care centers for evacuees; monitoring for radiological contamination; emergency worker preparedness; and public information in the form of brochures distributed to residents within the emergency preparedness zone. These programs are essential to the protection of the general public.

The information in Table 3.45 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.45. EMAP Impact Analysis: Nuclear Power Plants

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Health and Safety of Personnel Responding to the Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for trained and protected personnel.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require temporary relocation of operations.
Property, Facilities, and Infrastructure	Localized impact to facilities and infrastructure in the area of the incident. Some severe damage possible.
Delivery of Services	Localized disruption of lines of communication and destruction of facilities may postpone delivery of some services.
The Environment	May cause extensive damage in isolated cases and some denial or delays in the use of some areas. Remediation needed.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time, depending on damage and length of investigation.
Regulatory and Contractual Obligations	Regulatory requirements must be fulfilled. Fulfillment of some contracts may be difficult. Impact may reduce deliveries.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

Nuclear reactors have been designed to survive natural disasters such as tornadoes and earthquakes without damage to critical systems. Considerable emphasis is placed on multiple-level governmental reviews of the design, construction, and operation of each nuclear power plant. These safety reviews begin prior to construction and continue throughout the operating life of the plant. Radiological planning and preparedness programs monitored by state and federal agencies are in place to ensure that emphasis is placed on the safety of the general public within the emergency planning zone. In addition, the historical record for nuclear power plants gives no indication that a serious accident involving a nuclear power plant will occur.

3.2.15 Public Health Emergencies/Environmental Issues

Description of Hazard

Public health emergencies can take many forms—disease epidemics, large-scale incidents of food or water contamination, or extended periods without adequate water and sewer services. There can also be harmful exposure to chemical, radiological, or biological agents, and large-scale infestations of disease-carrying insects or rodents. The first part of this section focuses on emerging public health concerns and potential pandemics, while the second part addresses natural and human-caused air and water pollution.

Public health emergencies can occur as primary events by themselves, or they may be secondary to another disaster or emergency, such as tornado, flood, or hazardous material incident. For more information on those particular incidents, see Sections 3.2.9 (Tornadoes/Severe Thunderstorms), 3.2.7 (Riverine Flooding), and 3.2.12 (Hazardous Materials). The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, a large number of people. Public health emergencies can be worldwide or localized in scope and magnitude.

In particular, two public health hazards have recently emerged as issues of great concern, with far reaching consequences. One pertains to the intentional release of a radiological, chemical, or biological agent, as a terrorist act of sabotage to adversely impact a large number of people. For more information on biochemical terrorism, see Section 3.2.17. The second hazard concerns a deadly outbreak (other than one caused by an act of terrorism) that could kill or sicken thousands of people across the county or around the globe, as in the case of the Spanish Flu epidemic of 1918–1919.

Whether natural or manmade, health officials say the threat of a dangerous new strain of influenza virus in pandemic proportions is a very real possibility in the years ahead. Unlike most illnesses, the flu is especially dangerous because it is spread through the air. A classic definition of influenza is a respiratory infection with fever. Each year, flu infects humans and spreads around the globe. There are three types of influenza virus: Types A, B, and C. Type A is the most common, most severe, and the primary cause of flu epidemics. Type B cases occur sporadically and sometimes as regional or widespread epidemics. Type C cases are quite rare and hence sporadic, but localized outbreaks have occurred. Seasonal influenza usually is treatable, and the mortality rate remains low. Each year, scientists estimate which particular strain of flu is likely to spread, and they create a vaccine to combat it. A flu pandemic occurs when the virus suddenly changes or mutates and undergoes an “antigenic shift,” permitting it to attach to a person’s respiratory system and leave the body’s immune system defenseless against the invader.

Environmental concerns addressed in this profile focus on air and water pollution, because contamination of those media can have widespread impacts on public health and devastating consequences. Particular issues of primary concern associated with sources of air and water pollution change over time depending on recent industrial activity, economic development,

enforcement of environmental regulations, new scientific information on adverse health affects of particular contaminants or concentrations, and other factors.

Historical Statistics

Influenza Pandemics

Epidemic influenza, an age-old infectious disease, kills several thousand men and women in the United States every year. Since the early 1900s, three lethal pandemics have swept the globe, although none have compared to the infamous Spanish Flu event of 1918–1919, which killed more than 20 million people. The 1957 Asian Flu and the 1968 Hong Kong Flu also were killers, although they were not nearly as virulent as the 1918 strain. The 1957 epidemic killed about 70,000 people in the United States, mostly the elderly and chronically ill. Another 34,000 Americans died from the 1968 epidemic. While both of these latter epidemics cost many lives, neither was as severe as the Spanish Flu of 1918, which claimed more than 700,000 lives in the United States alone. Its primary victims were mostly young, healthy adults. In addition to those three pandemics, several “pandemic scares” have occurred.

Spanish Flu of 1918-1919

In 1918, when World War I was in its fourth year, another threat began that rivaled the war itself as the greatest killer in human history. The Spanish Flu swept the world in three waves during a two-year period, beginning in March 1918 with a relatively mild assault.

The first reported case occurred at Camp Funston (Fort Riley), Kansas, where 60,000 soldiers trained to be deployed overseas. Within four months, the virus traversed the globe, as American soldiers brought the virus to Europe. The first wave sickened thousands of people and caused many deaths (46 died at Camp Funston), but it was considered mild compared to what was to come. The second and deadliest wave struck in the autumn of 1918 and killed millions. At Camp Funston alone, there were 14,000 cases and 861 deaths reported during the first three weeks of October 1918.

Outbreaks caused by a new variant exploded almost simultaneously in many locations, including France, Sierra Leone, Boston, and New York City, where more than 20,000 people died that fall. The flu gained its name from Spain, which was one of the hardest hit countries. From there, the flu went through the Middle East and around the world, eventually returning to the United States along with the troops.

Of the 57,000 Americans who died in World War I, 43,000 died as a result of the Spanish Flu. At one point, more than 10 percent of the American workforce was bedridden. By a conservative estimate, a fifth of the human race suffered the fever and aches of influenza between 1918 and 1919 and 20 million people died.

In 1918, Missouri’s influenza death rate was 293.83 per 100,000 people, for a total of 9,677 deaths statewide from that cause alone. That figure represents18.6 percent of Missouri’s total

deaths that year. While the cause of the Spanish Flu remains somewhat a mystery, the epidemic was generally traced to pigs on Midwest farms, which then spread the deadly virus to farm families. As fall crops were ready for harvest in 1918, there were no field hands to get the crops in, thereby creating an agricultural disaster as well.

A third wave of the Spanish Flu, much less devastating than its predecessors, made its way through the world in early 1919 and then ly died out. Missouri's flu death rate in 1919 dropped to less than half that of the previous year (107.21 per 100,000), and by 1921, it was reduced to 87.24 deaths per 100,000 people, state statistics show.

Asian Flu of 1957

This flu pandemic was first identified in February 1957 in the Far East. Unlike the Spanish Flu, the 1957 virus was quickly identified, and vaccine production began in May 1957. A number of small outbreaks occurred in the United States during the summer of 1957, with infection rates highest among school children, young adults, and pregnant women; however, the elderly had the highest rates of death. A second wave of infections occurred early the following year, which is typical of many pandemics.

Hong Kong Flu of 1968

This influenza pandemic was first detected in early 1968 in Hong Kong. The first cases in the United States were detected in September 1968, although widespread illness did not occur until December. This became the mildest pandemic of the twentieth century, with those over the age of 65 the most likely to die. People infected earlier by the Asian Flu virus may have developed some immunity against the Hong Kong Flu virus. Also, this pandemic peaked during school holidays in December, limiting student-related infections.

Flu Scares: Swine Flu of 1976, Russian Flu of 1977, and Avian Flu of 1997

Three notable flu scares occurred in the twentieth century. In 1976, a swine-type influenza virus appeared in a U.S. military barracks (Fort Dix, New Jersey). Scientists determined it was an antigenically drifted variant of the feared 1918 virus. Fortunately, a pandemic never materialized, although the news media made a significant argument about the need for a Swine Flu vaccine.

In May 1977, influenza viruses in northern China spread rapidly and caused epidemic disease in children and young adults. By January 1978, the virus, subsequently known as the Russian Flu, had spread around the world, including the United States. A vaccine was developed for the virus for the 1978–1979 flu season. Because illness occurred primarily in children, this was not considered a true pandemic.

In March 1997, scores of chickens in Hong Kong's rural New Territories began to die—6,800 on three farms alone. The Avian Flu virus was especially virulent, and made an unusual jump from

chickens to humans. At least 18 people were infected, and six died in the outbreak. Chinese authorities acted quickly to exterminate over one million chickens and successfully prevented further spread of the disease.

Avian Flu (H5N1)

The current avian flu (H5N1) is a Type A influenza virus that occurs mainly in birds and is highly contagious among birds. Since December 2003, H5N1 infections in animals have been reported in Asia, Africa, the Pacific, Europe, and the Near East. H5N1 does not usually infect people, but a small number of human cases have been associated with these animal outbreaks and most are attributed to direct or close contact with infected poultry or contaminated surfaces. According to the Centers for Disease Control and Prevention, infection in humans is very serious with an approximately 50 percent mortality rate to date. Cases of transmission of H5N1 from human-to-human have been documented but are rare, and there is no evidence of transmission beyond one person.

Scientists are concerned that as H5N1 continues to evolve, it could make humans more susceptible to infection. Since humans have little or no immune protection against H5N1, such a change could spark an influenza pandemic with potentially high rates of illness and death. Two of four antiviral medications used for treating the flu have already proven ineffective against H5N1. Researchers are working to produce alternative treatments.

Other Diseases of Public Health Concern

Smallpox

Smallpox is a contagious, sometimes fatal, infectious disease. There is no specific treatment for smallpox disease, and the only prevention is vaccination. Smallpox is caused by the variola virus that emerged in human populations thousands of years ago. It is generally spread by face-to-face contact or by direct contact with infected bodily fluids or contaminated objects (such as bedding or clothing). A person with smallpox is sometimes contagious with onset of fever, but the person becomes most contagious with the onset of rash. The rash typically develops into sores that spread over all parts of the body. The infected person remains contagious until the last smallpox scab is gone. Smallpox outbreaks have occurred periodically for thousands of years, but the disease is now largely eradicated after a worldwide vaccination program was implemented. After the disease was eliminated, routine vaccination among the general public was stopped. The last case of smallpox in the United States was in 1949.

It should be noted that after recent terrorist events in the United States, there is heightened concern that the variola virus might be used as an agent of bioterrorism. For this reason, the U.S. government is taking precautions for dealing with a smallpox outbreak. For further information on this issue, see the Section 3.2.17 Terrorism.

St. Louis Encephalitis

In the United States, the leading type of epidemic flaviviral encephalitis is St. Louis encephalitis (SLE), which is transmitted by mosquitoes that become infected by feeding on birds infected with the virus. SLE is the most common mosquito-transmitted pathogen in the United States. There is no evidence to suggest that the virus can be spread from person to person.

Between 1964 and 2005, there were 4,651 confirmed cases of SLE in the United States. Seventy-five of these cases were in Missouri. According to the U.S. Geological Survey, there was one case of SLE in Missouri in 2006. It should be noted, however, that less than 1 percent of SLE infections are clinically apparent, so the vast majority of infections remain undiagnosed. Illnesses range from mild headaches and fever to convulsions, coma, and paralysis. The last major outbreak of SLE occurred in the Midwest from 1974 to 1977, when over 2,500 cases were reported in 35 states. The most recent outbreak of St. Louis encephalitis was in 1999 in New Orleans, Louisiana, with 20 reported cases. The disease is generally milder in children than in adults, with the elderly at highest risk for severe illness and death. Approximately 3 to 30 percent of cases are fatal; no vaccine against SLE exists.

Meningitis

Meningitis is an infection of fluid that surrounds a person’s spinal cord and brain. High fever, headache, and stiff neck are common symptoms of meningitis, which can develop between several hours to one to two days after exposure. Meningitis can be caused by either a viral or bacterial infection; however, a correct diagnosis is critically important, because treatments for the two varieties differ. Meningitis is transmitted through direct contact with respiratory secretions from an infected carrier. Primary risk groups include infants and young children, household contact with patients, and refugees. The disease is of most concern in Africa, where 213,658 cases were reported during 1996–1997, with 21,830 deaths. In the United States, periodic outbreaks continue to occur, particularly among adolescents and young adults. About 2,600 people in the United States get the disease each year. According to the Missouri Department of Health and Senior Services, there were 28 cases in Missouri in 2005. Generally, 10 to 14 percent of cases are fatal, and 11 to 19 percent of those who recover suffer from permanent hearing loss, mental retardation, loss of limbs, or other serious effects. Two vaccines are available in the United States.

Lyme Disease

Lyme disease was named after the town of Lyme, Connecticut, where an unusually large frequency of arthritis-like symptoms was observed in children in 1977. It was later found that the problem was caused by bacteria transmitted to humans by infected deer ticks, causing an average of more than 16,000 reported infections in the United States each year (however, the disease is greatly under-reported). Lyme disease bacteria are not transmitted from person to person. Following a tick bite, 80 percent of patients develop a red “bulls-eye” rash accompanied by tiredness, fever, headache, stiff neck, muscle aches, and joint pain. If untreated, some patients

may develop arthritis, neurological abnormalities, and cardiac problems, weeks to months later. Lyme disease is rarely fatal. During early stages of the disease, oral antibiotic treatment is generally effective, while intravenous treatment may be required in more severe cases.

In the United States, Lyme disease is mostly found in the northeastern, mid-Atlantic, and upper north-central regions, and in several counties in northwestern California. In 2005, 23,305 cases of Lyme disease were reported to the Centers for Disease Control and Prevention. According to the DHSS, in 2005, Missouri showed a decreasing trend for the occurrence of Lyme disease with 17 cases, the lowest since 1998 when 12 cases were reported. There have been no reported cases of Lyme disease that originated in Missouri.

West Nile Virus

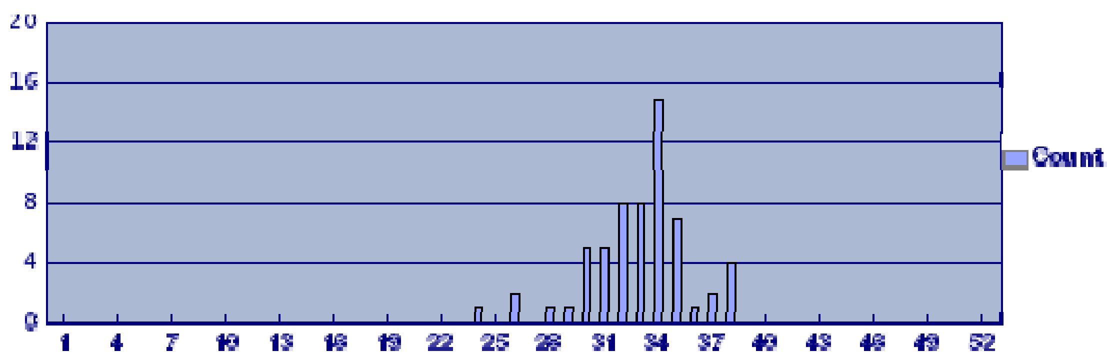
West Nile virus is a flavivirus spread by infected mosquitoes and is commonly found in Africa, West Asia, and the Middle East. It was first documented in the United States in 1999. Although it is not known where the U.S. virus originated, it most closely resembles strains found in the Middle East. It is closely related to St. Louis encephalitis and can infect humans, birds, mosquitoes, horses, and other mammals.

Most people who become infected with West Nile virus will have either no symptoms or only mild effects. However, on rare occasions, the infection can result in severe and sometimes fatal illness. There is no evidence to suggest that the virus can be spread from person to person.

An abundance of dead birds in an area may indicate that West Nile virus is circulating between the birds and mosquitoes in that area. Although birds are particularly susceptible to the virus, most infected birds survive.

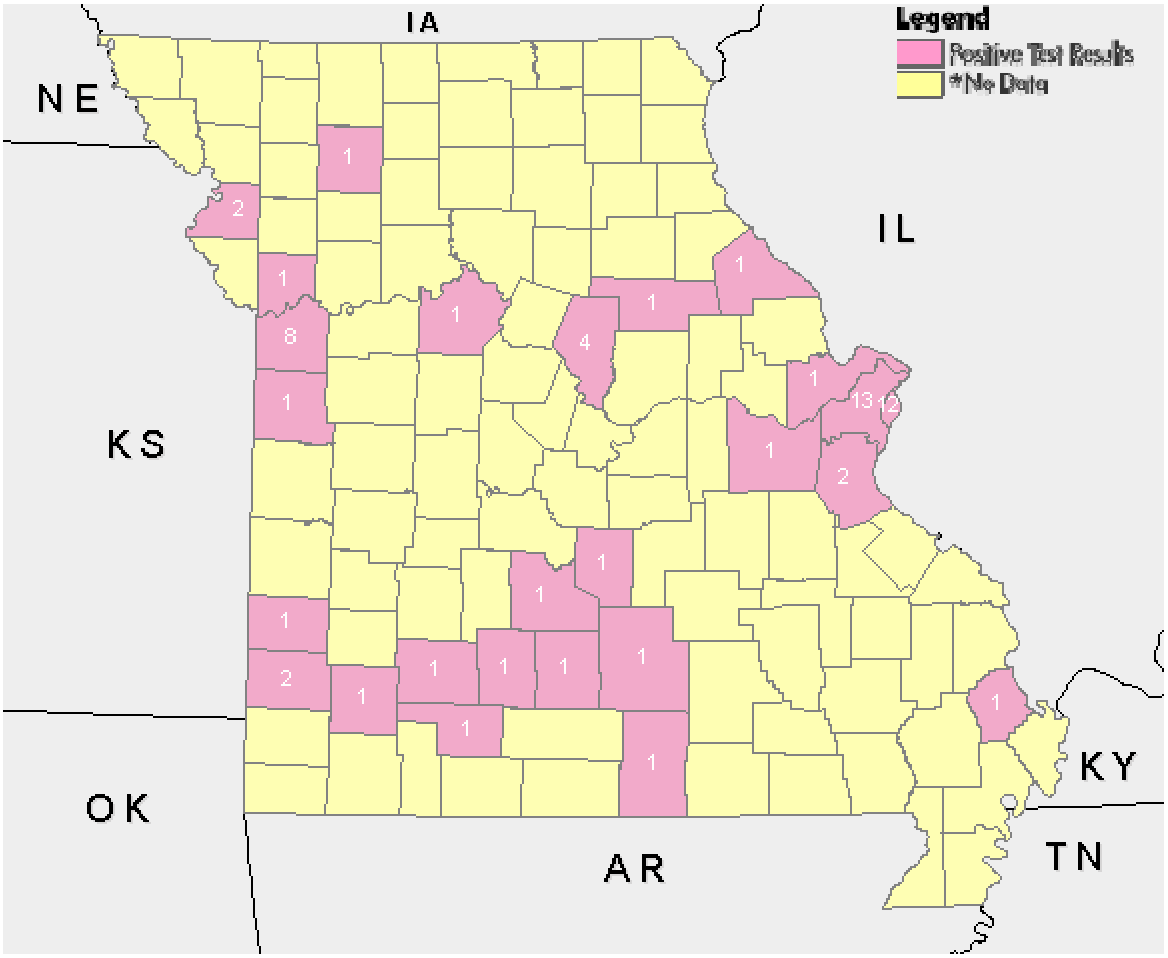
The continued expansion of West Nile virus in the United States indicates that it is permanently established in the Western Hemisphere. According to the U.S. Geological Survey, there were approximately 4,219 cases of West Nile Virus in the United States in 2006, including 62 in Missouri (see Figures 3.78 and 3.79 and Table 3.46).

Figure 3.78. Human Cases of West Nile Virus by Week—Missouri, 2006



Source: U.S. Geological Survey, Disease Maps 2006

Figure 3.79. Human Cases of West Nile Virus in Missouri, 2006



Source: U.S. Geological Survey, Disease Maps 2006 (as of February 6, 2007)

Table 3.46. West Nile Cases by County, Missouri, 2006

County	Number of Cases
Audrain	1
Barton	1
Boone	4
Buchanan	2
Cass	1
Christian	1
Clay	1
Daviess	1
Franklin	1
Greene	1
Howell	1
Jackson	8
Jasper	2
Jefferson	2
Laclede	1
Lawrence	1
Pike	1
Pulaski	1
St. Charles	1
St. Louis City	12
St. Louis	13
Saline	1
Scott	1
Texas	1
Webster	1
Wright	1

Source: U.S. Geological Survey, Disease Maps 2006

Severe Acute Respiratory Syndrome

Severe acute respiratory syndrome (SARS) is a respiratory illness that has recently been reported in Asia, North America, and Europe. Although the cause of SARS is currently unknown, scientists have detected in SARS patients a previously unrecognized coronavirus that appears to be a likely source of the illness.

In general, humans infected with SARS exhibit fevers greater than 100.4°F, headaches, an overall feeling of discomfort, and body aches. Some people also experience mild respiratory symptoms. After two to seven days, SARS patients may develop a dry cough and have trouble breathing.

The primary way that SARS appears to spread is by close person-to-person contact; particularly by an infected person coughing or sneezing contaminated droplets onto another person, with a transfer of those droplets to the victim's eyes, nose, or mouth. The global outbreak of 2003 was contained. There were no confirmed cases in Missouri.

Environmental Incidents

For information regarding historical incidents involving air and water pollution in Missouri, see Section 3.2.12.

Measure of Probability and Severity

Probability: High
Severity: Moderate to High

Health officials agree there is a high probability we will see another dangerous new strain of the influenza virus sometime in the future. In fact, a worldwide influenza outbreak on the scale and severity of the Spanish Flu is not far-fetched and is expected by many experts. Should such a killer-virus strike today, the results in Missouri and elsewhere could be catastrophic. Today, a much larger percentage of the world's population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means the virus could literally be spread around the globe within hours. Under such conditions, there may be very little warning time. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. Outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These and many other aspects make an influenza pandemic unlike any other public health emergency or community disaster.

Environmental concerns are also on the rise, with recent scientific data emphasizing the long-term impacts that air and water pollution can have on the ecology of affected areas. With continued enforcement of regulatory standards for airborne releases and discharges to waterways, routine emissions by industrial facilities are relatively easy to monitor and control. However, the potential always remains for unauthorized dumping and releases and for failure of systems to control industrial discharges, resulting in potential environmental emergencies.

Impact of the Hazard

For planning purposes, it is reasonable to assume a rapid movement of a pandemic flu virus from major metropolitan areas to rural areas of the state. The effect of a pandemic on individual communities would likely be relatively prolonged—weeks to months. The impact of the next pandemic could have a devastating effect on the health and well-being of Missouri citizens and the American public. For such an outbreak in the future, the Centers for Disease Control and Prevention estimates that in the United States alone:

- Up to 200 million persons will be infected;
- Between 40 and 100 million persons will become clinically ill;
- Between 18 and 45 million persons will require outpatient care;
- Between 300,000 and 800,000 persons will be hospitalized;

- Between 88,000 and 300,000 people will die nationwide;
- Effective preventive and therapeutic measures, including vaccines and antiviral agents, likely will be in short supply, as well as some antibiotics to treat secondary infections; and
- Economic losses from the next pandemic may range from $71 to 166 billion, depending on the attack rate.

Compared to public health emergencies, as previously described, environmental incidents involving air and water pollution would likely impact a more localized area; however, long-term affects on the environment in the impacted area could linger for many years.

The information in Table 3.47 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.47. EMAP Impact Analysis: Public Health Emergencies/Environmental Issues

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Health and Safety of Personnel Responding to the Incident	Adverse impact expected to be severe for unprotected personnel and uncertain for trained and protected personnel, depending on the nature of the incident.
Continuity of Operations	Danger to personnel in the area of the incident may require relocation of operations and lines of succession execution.
Property, Facilities, and Infrastructure	Access to facilities and infrastructure in the area of the incident may be denied until decontamination completed.
Delivery of Services	Disruption of lines of communication and destruction of facilities may extensively postpone delivery of services.
The Environment	Incident may cause denial or delays in the use of some areas. Remediation needed.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time.
Regulatory and Contractual Obligations	Regulatory waivers may be needed. Fulfillment of contracts may be difficult. Demands may overload ability to deliver.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

Public Health Emergencies

The Missouri Department of Health and Senior Services (DHSS) and SEMA were selected by the Centers for Disease Control and Prevention (CDC) and the Council of State and Territorial Epidemiologists to test a national plan for dealing with a catastrophic flu outbreak. MDHSS and SEMA designed an interactive exercise, FLUEX '98, to test two draft national response documents: (1) Influenza Pandemic Preparedness Action Plan for the United States, and (2) Pandemic Influenza: A Planning Guide for State and Local Officials. These documents were used for the design of FLUEX and during the exercise itself. FLUEX was held February 4–5, 1998, in the State Emergency Operations Center at SEMA headquarters in Jefferson City, Missouri, and included more than 100 participants. Missouri was the only state in the nation to hold such an exercise, and one of only six states to help test the proposed national plan. Major topics explored during FLUEX included the following:

- Identifying quickly circulating viruses
- Allocating potentially scarce vaccine supplies
- Communicating emergency health information to the public
- Keeping essential public safety services operating during a time of widespread illness among employees

As a follow-up to that planning event, FEMA conducted a satellite video conference on planning for an influenza pandemic, which was broadcast nationally on February 25, 1999. SEMA, DHSS, and local health departments hosted sites for the telecast across the state. The videoconference highlighted Missouri's planning efforts to date and featured health officials from Connecticut and Maine. They joined with a special panel at CDC headquarters in Atlanta, including SEMA's exercise officer, to answer a wide range of call-in questions on crisis management for a pandemic.

The sudden and unpredictable emergence of pandemic influenza and its potential for causing severe health, social, and economic consequences requires the need for a comprehensive, action-oriented strategy. Principal goals of the national plan are two-fold: to improve prevention and control of influenza in the United States during the present (interpandemic) period and to identify and implement specific ways and procedures to improve readiness for a future pandemic. As the CDC revises the draft national plan, Missouri will prepare an emergency response plan to deal with an influenza pandemic on the state level. The DHSS emphasizes that Missouri needs to prepare now to deal with challenges that could arise, such as vaccine shortages, widespread illness, and disruption in essential services. This was proven to be a pre-cursor for the bioterroism planning and exercising that was a result of the anthrax event that occurred in October 2001. Since this event, the DHSS and the local public health agencies in Missouri have played a significant role in all emergency/disaster preparedness.

Environmental Issues

Although Missouri has never had an environmental disaster of large proportions, there are many instances where hazardous substances can impact the environment with considerable consequences to either air or water. Floods often temporarily interrupt community water supplies, creating the need for emergency potable water for thousands of people. In July 1993, for example, St. Joseph’s municipal water plant was forced to shut down for an extended period when contaminated floodwater threatened to enter the system. Floodwaters also disrupt wastewater treatment facilities, resulting in the discharge of raw or improperly treated sewage. Periodically, water pollutants cause fish kills in Missouri streams, and excessive air pollutants associated with smog in large metropolitan areas create public health problems.

Air Pollution

Air quality in Missouri is monitored at 72 stations throughout the state. These stations are maintained by the U.S. Environmental Protection Agency (EPA), and state and local authorities. These stations can be divided into three separate groups: National Air Monitoring Stations, State and Local Air Monitoring Stations, and Special Purpose Monitors. These monitors measure suspended particulate, ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, and lead. Lead is of particular interest because Missouri’s lead industry produces about 90 percent of the new lead in the nation. The three large lead smelters in Missouri (near Herculaneum) have their own monitoring network operated by the company that runs the smelters. The state monitors the network to ensure proper function, and all data are forwarded to the EPA. The EPA maintains a list of facilities that release the most toxic chemicals each year. Missouri’s top 10 facilities for 2003 are shown in Table 3.48. The top 10 chemicals released in the state are shown in Table 3.49.

Table 3.48. Top 10 Facilities in Missouri Showing Greatest Releases (2003) (All figures are in pounds)

	On-Site Releases				Off-Site Releases		
Facility	**County**	**Air**	**Land**	**Water**	**POTW***	**Disposal**	**Total****
Buick Mine/Mill	Iron	54,678	15,349,076	10,305	0	0	15,414,059
Brushy Creek Mine/Mill	Reynolds	37,630	12,427,640	4,384	0	0	12,469,654
Fletcher Mine/Mill	Reynolds	32,295	10,126,988	2,560	0	0	10,161,843
Doe Run Co. Herculaneum Smelter	Jefferson	57,888	8,208,719	240	1,230	19,237	8,286,331
Doe Run Recycling Facility	Iron	20,227	0	421	0	5,261,770	5,282,418
Doe Run Co. Glover Smelter	Iron	35,230	3,807,803	35	0	193	3,843,261
Royal Oak Ent., Inc, Ellsinore, MO	Carter	3,512,016	0	0	0	0	3,512,016
Sweetwater Mine/Mill	Reynolds	9,262	3,341,743	585	0	0	3,351,590
AmerenUE Labadie Power Plant	Franklin	786,901	1,713,177	0	0	0	2,500,078
Craig Industrial	Shannon	2,385,936	0	0	0	0	2,385,936

Source: Missouri Toxic Resources Inventory Database 2003
Notes:
*Releases to POTWs (publicly owned treatment works) of metals or metal compounds only
**None of the values in this table include Dioxin or Dioxin-like compounds

Table 3.49. Top 10 Chemicals Reported in Missouri (2003) (All figures are in pounds)

	On-Site Releases			Off-Site Releases		
Chemical	**Air**	**Land**	**Water**	**POTW***	**Disposal**	**Total***
Zinc Compounds	553,007	25,138,975	15,374	68,052	702,026	26,477,434
Lead Compounds	223,255	20,405,171	3,008	1,166	4,513,911	25,145,345
Methanol	7,875,144	5	197	489,842	267	7,875,613
Barium Compounds	168,729	6,637,807	12,150	3	139,526	6,958,216
Copper Compounds	17,730	5,577,786	1,674	1,144	82,715	5,681,049
Hydrochloric Acid (“acid aerosols” only)	3,224,821	5	0	5	0	3,224,826
Aluminum (fume or dust)	6,627	2,425,093	0	0	104,000	2,535,720
Nitrate Compounds	1,024	1,528	2,409,312	2,440,385	4,081	2,415,945
Hydrogen Fluoride	2,315,016	0	0	0	0	2,315,016
Xylene (mixed isomers)	1,892,014	0	5	288	2,131	1,894,150

Source: Missouri Toxic Resources Inventory Database 2003
Note:
*These numbers include transfers of non-metals to POTWs (publicly owned treatment works), but transfers of non-metals to POTWs are considered off-site treatment, not releases to the environment, and are NOT included in the Total Releases column

Because of high amounts of ozone, carbon dioxide, nitrogen compounds, and other vehicular pollutants in the St. Louis metropolitan area, vehicles registered in the counties of St. Louis, St. Charles, and Jefferson, as well as St. Louis City, are required to have their exhaust systems routinely checked to determine whether emissions standards are being achieved. In addition, all service stations around St. Louis are now required to have new gas nozzles that recapture gasoline vapors, thus preventing them from being released to the atmosphere. These vapors (unburned hydrocarbons) chemically react with nitrogen oxides when exposed to the sunlight and form ozone, which is the basis for smog. For more information on Missouri's Air Pollution Control Program, contact the Missouri Department of Natural Resources.

Water Pollution

The Missouri Department of Natural Resources also maintains the state's water quality management plan and has developed individual plans for each drainage basin in Missouri. Those drainage basins may be divided into the following geographic categories: Upper Mississippi River tributaries, Lower Mississippi River tributaries, Missouri River tributaries north of the Missouri River, Missouri River tributaries south of the Missouri River, White River tributaries, and Arkansas River tributaries.

There are 22,203.1 miles of classified Missouri streams (i.e., permanently flowing streams or streams that maintain permanent pools during dry weather). Of these waters, 50 percent (11,120.1 miles) meet clean water goals for all recognized uses. There are 183.2 miles that are not able to be assessed. For the remaining 10,899.8 miles of water, water quality is seriously affected to the point that at least one recognized use of the waterbody has been lost.

There are 293,759 acres of classified lakes in Missouri. Of that area, 71 percent (209,368 acres) meet clean water goals for all recognized uses. There are 70 acres that are not able to be assessed. For the remaining 84,321 acres, water quality is seriously affected to the point that at least one recognized use of the waterbody has been lost.

According to the 2004 Water Quality Report, state concerns include the following:

- Channelization has caused aquatic habitat degradation in 17 percent of Missouri's streams and contributes to flooding, high water velocities, and streambank erosion as they try to recreate their natural sinuosity.
- Eutrophication of large, recreationally important reservoirs continues to be a concern.
- Mercury levels in fish in Missouri appear to be increasing over time.
- Abandoned lead-zinc mines and their tailings continue to impact waters decades after mining has ceased.
- Additional ground water protection measures are needed.
- There are 370 Class I confined animal feeding operations in Missouri.
- The data on fish that have been collected and the data on invertebrates that are still being collected indicate that many of these communities throughout the state are suffering from

degraded quality of aquatic habitat.

- Throughout all urban areas of the state, continuing suburban development impacts streams by the direct loss of stream channels, by shortening, culverting, and removing riparian areas, and by other impacts associated with development and increased stormwater flows.

For more information on Missouri's Water Pollution Control Program, contact the Missouri Department of Natural Resources at (573) 751-1300.

Identifying Pollution Hazard Areas

Local emergency management officials should identify pollution hazard areas so that in case of a natural disaster, recovery steps will not be delayed. Pollution of public drinking water, for example, can cause severe problems with reentry and recovery. If alternate sources of safe drinking water can be identified, or relocation of water intakes can eliminate polluted drinking water, then recovery can be quicker, and local resources can be used to address other problems.

With the increases in motor vehicle registrations throughout the state, the levels of nitrocarbon emissions will naturally rise. Combinations of smog and carbon monoxide levels will also increase. In sufficient quantities, these pollutants can have deleterious effects on the health of thousands of Missourians.

3.2.16 Special Events

National Special Security Events

A number of factors are taken into consideration when designating an event as a national special security event (NSSE), including the following:

- **Anticipated attendance by dignitaries—**Events that are attended by officials of the United States Government and/or foreign dignitaries may create an independent federal interest in ensuring that the event transpires without incident and that sufficient resources are brought to bear in the event of an incident.
- **Size of the event—**A large number of attendees and participants generally increases the security requirements. In addition, larger events are more likely to draw the attention of terrorists or other criminals, particularly those interested in employing weapons of mass destruction.
- **Significance of the event—**Some events have historical, political, and/or symbolic significance that may heighten concern about possible terrorist acts or other criminal activity.

When an event is designated as an NSSE, the Secret Service assumes its mandated role as the lead federal agency for the design and implementation of the operational security plan and coordinator for all federal resources deployed to maintain the level of security needed for the designated events. The Federal Bureau of Investigation (FBI) serves as the lead agency responsible for intelligence and law enforcement operations as well as statutory federal criminal investigations. The goal of such an operation is to prevent terrorist attacks and criminal acts.

Once an event is designated as an NSSE, the Secret Service employs existing partnerships with federal, state, and local law enforcement and public safety officials to coordinate provision of a safe and secure environment for the event and those in attendance.

Resources used as part of past NSSE operational security plans that could be deployed for upcoming NSSE designated events include physical infrastructure security fencing and barricades, special access accreditation badges, K-9 teams, and other security technologies.

The Secret Service is responsible for planning, directing and executing federal security operations at designated NSSE's. It also provides federal, state, and local law enforcement partners who provide substantial, critical support to the protective mission with the necessary guidance and training regarding their role in the overall operational security plans.

The Emergency Preparedness and Response division within the U.S. Department of Homeland Security could preposition some combination of the following assets: the Domestic Emergency Support Team, Urban Search and Rescue teams, national Emergency Response Teams, the Nuclear Incident Response Team, the Strategic National Stockpile and Mobile Emergency Response System. The specific package will be tailored for each individual event based on coordination with other federal agencies, state and local jurisdictions, available local resources, mutual aid agreements, and other event-specific requirements.

Special Event Homeland Security (SEHS) Levels

Managed by the U.S. Department of Homeland Security, the Interagency Special Events Working Group (SEWG) is the core of an interagency process that involves various federal agencies. Within the SEWG, federal departments and agencies provide input and recommendations concerning special events based on their respective authorities, responsibilities, and fields of expertise. The SEWG is co-chaired by designees from DHS headquarters, the Secret Service, FEMA, and the FBI and is currently made up of representatives from over 40 federal departments and agencies that have responsibilities and/or association with special events security and incident management. The SEWG develops the Prioritized List of Special Events, recommends special event homeland security (SEHS) levels, and is the single forum that ensures comprehensive and coordinated federal interagency awareness of and support to designated special events.

The Prioritized List of Special Events is the single interagency resource delineating domestic events, activities, or meetings that do not rise to the level of a National Security Special Event, but which nevertheless are significant. Using a risk-based approach to weigh vulnerabilities and consequences against threats, the SEWG develops the Prioritized List of Special Events from event recommendations submitted by each state, territory, and the District of Columbia. The events are categorized into one of the four SEHS levels using objective criteria including but not limited to size, threat, symbolic or political significance, duration, location, number and type of attendees, media coverage, dignitary participation, proximity of critical infrastructure, and state and local capabilities. Federal support is scaled according to the SEHS level. SEHS-IV only

requires maintaining federal situational awareness of the event while a wide variety of federal prevention, protection, and response resources may be provided for SEHS-I events. Events that do not reach the threshold of SEHS-IV are not included on the list. The SEHS levels are defined as follows:

- **SEHS-I—**An event of large magnitude and significant national and/or international importance requiring significant federal support and situational awareness. This designation requires the appointment of a federal coordinator and the development of an integrated federal support plan.
- **SEHS-II—**An event of medium magnitude and average national and/or international importance requiring federal support and situational awareness. This designation also requires the appointment of a federal coordinator and the development of an integrated federal support plan.
- **SEHS-III—**An event of low magnitude and low national and/or international importance requiring limited federal support and situational awareness. Monitoring and federal coordination for support are accomplished through the Homeland Security Operations Center (HSOC) and the SEWG.
- **SEHS-IV—**An event that requires federal awareness but does not warrant direct federal support or involvement. DHS may assist state and local jurisdictions by providing training and exercise opportunities through existing and/or tailored programs. The HSOC will maintain awareness of the event.

Description of Hazard

Significant special events may include any type of event where large groups of people are gathered together, regardless of the cause or purpose of the event, where expanded security and other resources are required above and beyond the resources typically available to local and/or state government. In such instances, event sponsors, in conjunction with local and state authorities, are responsible for coordinating the event and requesting federal assistance, if necessary.

Special events may be motivated by political, economic or social causes, as in the case of inaugurations, state of the union addresses, and summit conferences, or by recreational causes, as with the Olympics and other major sporting events (Super Bowl, World Series, etc.). Special events may also include large holiday events such as the annual Fair St. Louis 4th of July Celebration, where large numbers of people crowd onto the Mississippi Riverfront in St. Louis.

The perception of inherent dangers and threats facing this country and Missouri has changed significantly since the terrorist attacks of September 11, 2001. In keeping with the framework of the National Response Plan, the Missouri State Emergency Operations Plan should consider special events as described herein. The following historical statistics section details some of the potential impacts on security and medical resources that a special event could have.

Anytime a large number of people are congregated in one area, an incident resulting from just about any of the hazards detailed in this Hazard Analysis could have devastating impacts. For example, consider the impact a sudden, severe hailstorm could have on the population visiting the Fair St. Louis, which well over one million people usually attend each year. A hailstorm such as this struck the north St. Louis County area in April 2001, causing thousands of dollars of damage to residences and vehicles. This storm produced baseball-size (and larger) hailstones, which killed many pets and nearly all the waterfowl residing at local park ponds. An incident such as this could have devastating impacts if it were to suddenly strike the fairgrounds with over 250,000 people in attendance and without shelter (not to mention the potential impact a terrorist attack incident could impose at such an event). Medical services would likely be overwhelmed with the number of injuries.

Historical Statistics

Atlanta, Georgia, Centennial Olympic Park Bombing

On Saturday July 27, 1996, Georgia Bureau of Investigation (GBI) agents in Atlanta were dispatched to the Centennial Olympic Park for what seemed like a routine public disturbance call on the ninth day of the 1996 Summer Olympics. Apparently, some rowdy partygoers had been creating a scene at the event.

By the time GBI agents arrived, the partiers were gone. However, a security guard pointed out another problem: a green knapsack left unattended under a nearby bench. Because of the suspicious nature of the situation, a bomb diagnostic team was called as officers attempted to keep people away from the area without creating a panic. They were unaware that a warning call had been made to 911 emergency dispatchers.

About 20 minutes later, as agents were assessing the situation and continuing to attempt to steer people away from the abandoned bag, it blew up with a powerful explosion. The blast killed one visitor and injured more than 100. All of the law officers at the scene were injured except for one. A Turkish cameraman died of a heart attack while covering the explosion.

FBI said of this incident, “The fatal bombing in Atlanta was a terrorist attack aimed at thousands of innocent persons gathered at the Olympic Park.” This blast was the worst attack on an Olympic Games since 11 Israeli athletes were killed by Palestinian guerrillas at the 1972 games in Munich, Germany.

St. Louis, Missouri, Papal Visit

Pope John Paul II visited St. Louis, Missouri, on January 26 and 27, 1999. This pastoral visit included 30 hours of speeches, parades, prayer services, and a papal mass for about 104,000 people at the St. Louis America’s Center, which filled every available seat in the center, including the Edward Jones Dome and adjoining convention exhibit hall. This mass is billed as the largest U.S. indoors gathering ever and was designated a National Special Security Event.

This two-day series of events also included a welcome address by President Bill Clinton and ceremonial farewell meeting with Vice-President Al Gore and was attended by many state officials, including Missouri Governor Mel Carnahan. Event activities were spread throughout the St. Louis metropolitan area, from the Lambert–St. Louis International Airport to the downtown area and the grounds of the Gateway Arch on the Mississippi Riverfront.

This was undoubtedly the largest single special event to occur in Missouri in recent years, with security concerns reaching to national and international levels. Close coordination between local, state, and federal law enforcement agencies is required to provide adequate security measures for events like this. The potential for hazards from mass transportation accidents was also elevated for this event, as one quote said, “Seemingly every school bus in the region was enlisted to transport people from suburban pickup points down into St. Louis America’s Center for the papal mass.” Fortunately, this event was conducted without any major incidents.

St. Louis, Missouri, World Agricultural Forum Conference

The Hyatt Regency Hotel at Union Station in St. Louis hosted the World Congress meeting of the World Agricultural Forum May 18 to 20, 2003. The forum brought together agriculture industry leaders and world leaders to discuss the future of global agriculture. Mindful of Seattle’s experience with violent protestors who disrupted the World Trade Organization (WTO) meeting there in December 1999, St. Louis police were braced for any possible problems that could arise from hundreds or even thousands of protestors descending on St. Louis for this event.

Four Seattle police officers were invited to St. Louis to talk about what happened at the 1999 WTO event (50,000 demonstrators overwhelmed 400 Seattle officers and protestors smashed windows and vandalized cars as police fought back with rubber bullets and tear gas). Washington, DC, police were also invited to St. Louis to share their experiences with riots during protests of major global conferences in their city.

Although St. Louis police were not anticipating the same level or intensity of violence as in Seattle, they did have intelligence reports that some visitors would be in St. Louis who were involved in the Seattle protests and other demonstrations. Another conference, called Biodevastation 7, was scheduled immediately prior to the World Agricultural Forum (May 16 to 18, 2003) in St. Louis, which involved a gathering of opponents to genetic engineering. An organizer with the group had indicated that 200 to 800 people were expected to attend the Biodevastation 7 conference and that there would be 200 to 2,000 protestors at the World Agricultural Forum.

During this time period, in nearby Creve Coeur, Missouri, extra police were also on hand at the Monsanto property for the annual Creve Coeur Days. Monsanto, an agriculture industry leader, is a host of the annual celebration, which includes carnival rides and game booths on its property. Creve Coeur police coordinated a plan with St. Louis police to gather information about possible protests at this event.

A local international security consulting firm was in charge of security for the World Agricultural Forum conference. They worked with St. Louis police and other law enforcement agencies to prepare for possible protests at the event. Close coordination between these agencies helped to ensure that St. Louis was prepared to provide adequate security for the event and the international visitors to the city. Other than a couple of minor incidents between police and activists in the days leading up to the conference, no incidents were reported. A protest outside the conference on May 18 drew only a few hundred demonstrators, all peaceful, and only a handful of demonstrators were present during the event's two days.

The following are recent events in Missouri considered for SEHS designation requiring significant state and local resources**:**

- St. Louis, May 2004, World Agricultural Forum Regional Congress
- St. Peters, June 2004, U.S. Olympic diving trials
- Clayton, October 2004, presidential debate
- St. Louis, October 2004, Major League Baseball World Series
- St. Louis, April 2005, National Collegiate Athletic Association Division I Men's Basketball Four Tournament

Measure of Probability and Severity

Probability: Low to Moderate
Severity: Low to High

Missouri will undoubtedly host future special events that will require significant security and other emergency planning considerations. The overall probability that a disastrous incident from any cause would occur in conjunction with a designated special event or special security event is considered low to moderate. The probability for an incident to occur during any particular special event is really a function of the hazards previously detailed in this Hazard Analysis and the probability of the independent occurrences of these hazards. However, special events will unfortunately continue to be likely targets for protests, rioting, and terrorist attacks in the United States. Refer to the measure of probability and severity discussions on the other hazards for more specific considerations.

The severity of incidents occurring in conjunction with designated special events could range from low to high, depending on many factors. The severity of these incidents will be a function of the number of people attending these events and the type and severity of the specific hazards that affect the events. Considerations of severity could range from a hoax bomb scare or terrorist threat where no one is physically injured and without any property damage to a full-scale disaster affecting a large number of people gathered at one time with mass injuries and property damage by natural, accidental, terrorist, or criminal causes. Refer to the measure of probability and severity discussions on the other hazards for more specific considerations.

Impact of the Hazard

As with the measure of probability and severity, the potential impact of hazards occurring in association with any special event must be evaluated as a function of the specific hazard that could cause the impact on a large number of people attending any event. Refer to the impact of the hazard discussions in other hazard profiles for more hazard-specific impact considerations. Certainly, the potential impact of any hazard can be multiplied several-fold when it affects a large number of people all at once.

The information in Table 3.50 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.50. EMAP Impact Analysis: Special Events

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	May be severe for unprotected personnel and moderate to light for protected personnel in incident area.
Health and Safety of Personnel Responding to the Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for trained, equipped, and protected personnel.
Continuity of Operations	Danger to personnel in the area of the incident may require relocation of operations and lines of succession execution.
Property, Facilities, and Infrastructure	Facilities and infrastructure in the area of the incident may be denied until incident resolved.
Delivery of Services	Localized disruption of roads and/or utilities caused by incident may postpone delivery of some services.
The Environment	Localized adverse impact depending on the nature of the incident.
Economic and Financial Condition	Localized adverse impact depending on the nature of the incident.
Regulatory and Contractual Obligations	Localized adverse impact depending on the nature of the incident.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

Adapted from the National Response Plan (NRP): The perception of inherent dangers and complex threats facing this country and the potential consequences they could have on the American way of life has changed significantly since the terrorist attacks of September 11, 2001. These threats cross a broad spectrum of contingencies from acts of terrorism to natural disasters to other manmade hazards (accidental or intentional). Because all carry the potential for severe

consequences, these threats must be addressed with a unified national effort. A new paradigm for incident management is required. This philosophy has been the mandate for change leading to development of the NRP.

This section has been added to the Hazard Analysis in keeping with the framework of the NRP. The NRP is designed as an "all-hazards/all-disciplines" plan and considers hazards under the full range of possible contingencies, including natural disasters, accidents, civil/political incidents, terrorist/criminal incidents, and significant events/designated special events.

Significant special events are any type of event where large groups of people are gathered and expanded security and other resources are required above and beyond the resources typically available to local or state government. Special events may be motivated by political, economic, or social causes, as in the case of inaugurations, state of the union addresses, and summit conferences, or they may be motivated by recreational causes as with major sporting events or designated holiday events.

Regardless of the purpose or cause, special events will place a large number of people in one area at one time. Anytime people are crowded together in one place, an incident resulting from just about any of the hazards detailed in this Hazard Analysis could have compounded and devastating impacts.

In such instances, event sponsors, in conjunction with local and state authorities, are responsible for coordinating the event and requesting assistance at the federal level, if necessary. Local and state authorities are responsible for coordinating requirements from the organization sponsoring an event and determining resource shortfalls and submitting resource requests, through the existing structures and mechanisms, to the national level for consideration. Event sponsors are responsible for developing concepts for conducting the event, identifying resource requirements necessary to support the event, and submitting resource requests to local and state governments for consideration.

3.2.17 Terrorism

Description of Hazard

Terrorism, as defined by the Federal Bureau of Investigation (FBI), is "the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." The effects of terrorism can vary significantly, including loss of life, injuries to people and properties, and disruptions in services (e.g., water supplies, public transportation, and communications).

According to the FBI, there are two primary types of terrorism:

- **Domestic Terrorism** involves groups or individuals whose terrorist activities are directed at elements of our government or populations without foreign direction.

- **International Terrorism** involves terrorist activity committed by groups or individuals who are foreign-based and/or directed by countries or groups outside the United States or whose activities transcend national boundaries.

Forms of Terrorism

Terrorism can take place in various forms, depending on the technological means available to the terrorist group, the nature of the issue motivating the attack, and the points of weakness of their target. Potential terrorist actions include the following:

- **Bombings—**Bombings have long been used in terrorist attacks and probably represent the most "traditional" form of terrorism. These types of incidents range from small-scale letter bombs to large-scale attacks on specific buildings. Other bomb-related incidents frequently involve "suicide bombers," who sacrifice themselves for their cause.
- **Airline Attacks—**In the past, terrorist acts involving aircrafts were generally restricted to hijackings and bombings. However, the attacks on the World Trade Center buildings in New York City in 2001 brought a new avenue to light—the use of commercial aircrafts to attack infrastructure targets. Surface-to-air missile attacks also present a threat to U.S. aircrafts.
- **Weapons of Mass Destruction (WMD) Attacks—**WMD attacks usually involve nuclear weapons or biological or chemical agents. Chemical and biological agents are infectious microbes or toxins used to produce illness or death. They can be dispersed as aerosols or airborne particles directly onto a population, producing an immediate effect (a few seconds to a few minutes) or a delayed effect (several hours to several days). Severity of injuries depends on the type and amount of the agent used and duration of exposure. Because some biological agents take time to grow and cause disease, an attack using this type of agent may go unnoticed for several days.
- **Infrastructure Attacks—**These types of attacks can impact various potential targets, including water distribution systems and treatment plants, utility companies and services, emergency services, gas and oil production facilities, telecommunications centers, transportation terminals, media facilities, government buildings, and religious institutions.
- **Cyberterrorism—**Cyberterrorism pertains to attacks on computer-based systems that are designed to spread disinformation and propaganda, deny service to legitimate computer users, spread electronic viruses to corrupt vital data, or cause critical infrastructure outages. Political conflicts that have led to attacks on cyber systems include clashes between India and Pakistan, Israel and the Palestinians, the North Atlantic Treaty Organization, and Serbia.
- **Agroterrorism—**Agroterrorism involves intentional contamination of commercial produce or meat supplies. Because the United States supplies approximately 16 percent of the world's meat, 40 percent of its soybeans, and 41 percent of its corn, a deadly fungus or bacteria could be devastating. Of the 222 possible bioterrorism attacks that have occurred worldwide in the twentieth century, only 17 of these targeted commercial livestock or plants, according to the Institute for National Strategic Studies.
- **Arson—**Intentional fires have caused extensive damage during terrorist-related incidents in the past. These types of incidents may also be associated with bombings and usually target

specific structures, such as churches. Although deliberately set fires have been reported at 15 churches in Missouri, none have been determined to be hate crime-related or terrorist-related incidents.

- **Kidnappings/Assassinations—**Kidnappings and assassinations may also be terrorist-related incidents, but because these events generally involve few individuals, their effect on emergency management operations may be minimal in terms of response.

Domestic Terrorism

According to the FBI, domestic terrorist groups represent interests that span the full spectrum of political and economic viewpoints, as well as social issues and concerns. The current domestic terrorist threat comes primarily from white supremacists, black separatists, animal rights/environmental terrorists, anarchists, antiabortion extremists, and self-styled militia.

- **White Supremacists or Right-Wing Terrorists—**Right-wing terrorist groups often adhere to the principles of racial supremacy and embrace antigovernment, antiregulatory beliefs. Generally, extremist right-wing groups engage in activities that are protected by constitutional guarantees of free speech and assembly. Examples of this type of group include Aryan Nations, the Order, and Posse Comitatus. Missouri has seen some activity from these groups in the past few years. According to the Southern Poverty Law Center, Missouri has two extremist groups operating within its borders. Although a state statute against paramilitary training exists, one of these groups is also known to have such a facility in Missouri. In addition, several special gatherings of extremist groups have taken place within the state in recent years.
- **Black Separatists—**United States-based black separatist groups follow radical variants of Islam and in some cases express solidarity with al-Qa’ida and other international terrorist groups.
- **Animal Rights and Environmental Terrorists—**Operating under the umbrella of the Animal Liberation Front and Earth Liberation Front, these terrorists use a variety of tactics against their targets, including arson, sabotage/vandalism, theft of research animals, and the occasional use of explosive devises
- **Anarchists—**The potential for violence by anarchists and other emerging revolutionary groups, such as the Anarchist Black Cross Federation (ABCF), will continue to be an issue for law enforcement. The stated goals of the ABCF are “the abolishment of prisons, the system of laws, and the capitalist state.” The ABCF believes in armed resistance to achieve a stateless and classless society. The ABCF has continued to organize, recruit, and train anarchists in the use of firearms.
- **Antiabortion Extremists—**The FBI investigates antiabortion groups. Potential violent anti-abortion extremists linked to terrorism ideologies or groups pose a current threat.

International Terrorism

The United States continues to face a formidable challenge from international terrorism. In general terms, the international terrorist threat can be divided into three categories: loosely

affiliated extremists operating under the radical jihad movement, formal terrorist organizations, and state sponsors of terrorism. Each of these categories, which represent threats to U.S. citizens and interests both abroad and at home, are described below:

- **Loosely Affiliated Extremists—**These are motivated by political or religious beliefs, and pose the most urgent threat to the United States.
- **Formal Terrorist Organizations—**These organizations are typically autonomous and have their own infrastructures, personnel, financial arrangements, and training facilities.
- **State Sponsors of Terrorism—**This category includes countries known to sponsor terrorism and to view it as a tool of foreign policy. Currently, the U.S. Department of state recognizes seven countries in this category: Iran, Iraq, Sudan, Libya, Syria, Cuba, and North Korea.

Foreign Terrorist Organizations (FTOs) are foreign organizations that are designated by the secretary of state in accordance with Section 219 of the Immigration and Nationality Act, as amended by the Antiterrorism and Effective Death Penalty Act of 1996. A list is compiled every two years. The current list of FTOs, released in October 2005, designates the following organizations:

- Abu Nidal Organization (ANO)
- Abu Sayyaf Group
- Al-Aqsa Martyrs Brigade
- Ansar al-Islam
- Armed Islamic Group (GIA)
- Asbat al-Ansar
- Aum Shinrikyo
- Basque Fatherland and Liberty (ETA)
- Communist Party of the Philippines/New People's Army (CPP/NPA)
- Continuity Irish Republican Army
- Gama'a al-Islamiyya (Islamic Group)
- HAMAS (Islamic Resistance Movement)
- Harakat ul-Mujahidin (HUM)
- Hizballah (Party of God)
- Islamic Jihad Group
- Islamic Movement of Uzbekistan (IMU)
- Jaish-e-Mohammed (JEM) (Army of Mohammed)
- Jemaah Islamiya organization (JI)
- al-Jihad (Egyptian Islamic Jihad)
- Kahane Chai (Kach)
- Kongra-Gel (KGK, formerly Kurdistan Workers' Party, PKK, KADEK)
- Lashkar-e Tayyiba (LT) (Army of the Righteous)
- Lashkar i Jhangvi

- Liberation Tigers of Tamil Eelam (LTTE)
- Libyan Islamic Fighting Group (LIFG)
- Moroccan Islamic Combatant Group (GICM)
- Mujahedin-e Khalq Organization (MEK)
- National Liberation Army (ELN)
- Palestine Liberation Front (PLF)
- Palestinian Islamic Jihad (PIJ)
- Popular Front for the Liberation of Palestine (PFLF)
- PFLP-General Command (PFLP-GC)
- al-Qa'ida
- Real IRA
- Revolutionary Armed Forces of Colombia (FARC)
- Revolutionary Nuclei (formerly ELA)
- Revolutionary Organization 17 November
- Revolutionary People's Liberation Party/Front (DHKP/C)
- Salafist Group for Call and Combat (GSPC)
- Shining Path (Sendero Luminoso, SL)
- Tanzim Qa'idat al-Jihad fi Bilad al-Rafidayn (QJBR) (al-Qaida in Iraq) (formerly Jama'at al-Tawhid wa'al-Jihad, JTJ, al-Zarqawi Network)
- United Self-Defense Forces of Colombia (AUC)

The following groups of concern have not been designated as FTOs, but many have been designated under other U.S. government counterterrorism authorities.

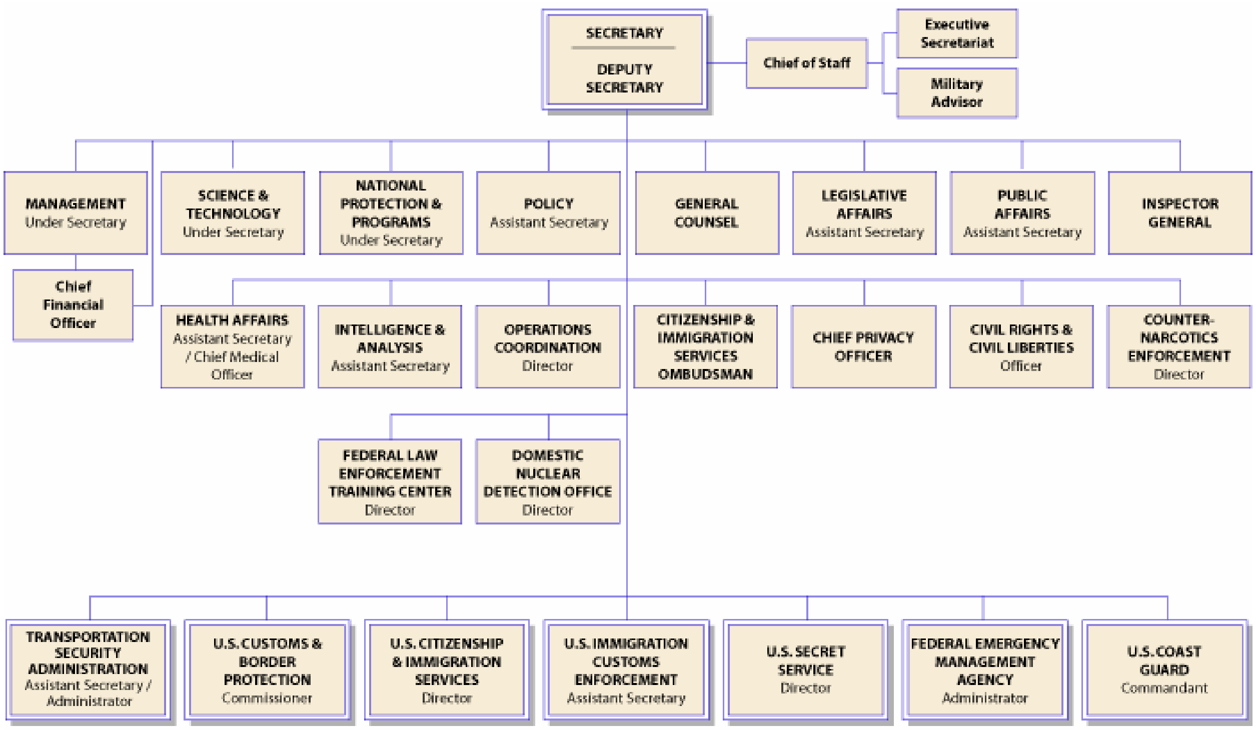
- Al-Badhr Mujahedin (al-Badr)
- Al-Ittihad al-Islami (AIAI)
- Alex Boncayao Brigade (ABB)
- Anti-Imperialist Territorial Nuclei (NTA)
- Army for the Liberation of Rwanda (ALIR)
- Cambodian Freedom Fighters (CFF)
- Communist Party of India (Maoist)
- Communist Party of Nepal (Maoist)/United People's Front
- Democratic Forces for the Liberation of Rwanda (FDLR)
- East Turkistan Islamic Movement (ETIM)
- First of October Antifascist Resistance Group (GRAPO)
- Harakat ul-Jihad-I-Islami (HUJI)
- Harakat ul-Jihad-I-Islami/Bangladesh (HUJI-B)
- Hizb-I Islami Gulbuddin (HIG)
- Hizbul-Mujahedin (HM)
- Irish National Liberation Army (INLA)
- Irish Republican Army (IRA)

- Islamic Army of Aden (IAA)
- Islamic Great East Raiders–Front (IBDA-C)
- Islamic International Peacekeeping Brigade (IIPB)
- Jamaatul-Mujahedin Bangladesh (JMB)
- Jamiat ul-Mujahedin (JUM)
- Japanese Red Army (JRA)
- Kumpulan Mujahedin Malaysia (KMM)
- Lord's Resistance Army (LRA)
- Loyalist Volunteer Force (LVF)
- New Red Brigades/Communist Combatant Party (BR/PCC)
- People Against Gangsterism and Drugs (PAGAD)
- Rajah Solaiman Movement (RSM)
- Red Hand Defenders (RHD)
- Revolutionary Proletarian Initiative Nuclei (NIPR)
- Revolutionary Struggle (RS)
- Riyadus-Salikhin Reconnaissance and Sabotage Battalion of Chechen Martyrs
- (RSRSBCM)
- Sipah-I-Sahaba/Pakistan (SSP)
- Special Purpose Islamic Regiment (SPIR)
- Tunisian Combatant Group (TCG)
- Tupac Amaru Revolutionary Movement (MRTA)
- Turkish Hizballah
- Ulster Defense Association/Ulster Freedom Fighters (UDA/UFF)
- Ulster Volunteer Force (UVF)
- United Liberation Front of Assam (ULFA)

Government Authority

After the attacks on September 11, 2001, parts of 22 domestic agencies were consolidated into one department, the U.S. Department of Homeland Security (DHS), to protect the nation against future terrorist threats. Roles of those agencies include analyzing threats and intelligence, guarding national borders and airports, protecting critical infrastructure, and coordinating response efforts for future emergencies. Many feel the creation of DHS is the most significant transformation of the U.S. government in the last 50 years. The current organization of DHS is illustrated in Figure 3.80.

Figure 3.80. DHS Organization



The FBI is the lead federal agency for investigating terrorism. The FBI is authorized to open an investigation whenever "facts or circumstances reasonably indicate that two or more persons are engaged in an enterprise for the purpose of furthering political or social goals wholly or in part through activities that involve force or violence and a violation of the criminal laws of the United States." In any given year, the FBI engages in approximately 24 full-scale domestic terrorism investigations. The FBI maintains a state-of-the-art computer database known as the Terrorist Information System, which contains information on known or suspected terrorist groups and individuals. The system contains information on over 200,000 individuals and over 3,000 organizations.

An essential weapon in the battle against terrorists is the Joint Terrorism Task Force (JTTF). A national JTTF, located at FBI Headquarters, includes representatives from the U.S. Department of Defense, U.S. Department of Energy, FEMA, Central Intelligence Agency, Customs Service, Secret Service, and the Immigration and Naturalization Service. Additionally, there are 66 local JTTFs where representatives from federal agencies, state and local law enforcement personnel, and first responders work together to track down terrorists and prevent acts of terrorism in the United States. There are two JTTFs in Missouri, one in Kansas City and one in St. Louis.

After terrorist-related events, communities may receive assistance from state and federal agencies operating within the existing Integrated Emergency Management System. FEMA is the lead federal agency for supporting state and local response to the consequences of terrorist attacks.

Historical Statistics

The following section highlights noteworthy terrorist-related threats and actual attacks that have occurred in the United States since 1970.

In 1972, members of a U.S. fascist group called Order of the Rising Sun were found in possession of 30 to 40 kilograms of typhoid bacteria cultures, which they planned to use to contaminate water supplies in Chicago, St. Louis, and other large Midwestern cities.

In 1984, two members of an Oregon cult headed by Bhagwan Shree Rajneesh cultivated Salmonella bacteria and used it to contaminate restaurant salad bars in an attempt to affect the outcome of a local election. Although approximately 751 people became ill and 45 were hospitalized, there were no fatalities.

In February 1993, an improvised bomb exploded in a rental van parked on the second level of the World Trade Center's parking basement. The bomb contained approximately 1,200 to 1,500 pounds of a homemade fertilizer-based explosive, urea nitrate. The blast produced a crater 150 feet in diameter and five floors deep. Although the motive for the attack was never confirmed, it is believed that the suspect who masterminded the bombing was either backed by a loose network of militant Muslims or directed by Iraq. The incident, which killed 6 people and injured more than 1,000, was the most significant international terrorist act that had ever been committed on U.S. soil at that time.

In April 1995, a massive bomb exploded inside a rental truck parked near the Murrah Federal Building in Oklahoma City, destroying half the nine-story building and killing 168 people. The incident was traced to Timothy McVeigh, who was convicted of the bombing and executed by lethal injection in June 2001. He was the first federal prisoner to be executed in 38 years. McVeigh was a survivalist who believed individual rights (e.g., gun control) were being deprived by government agencies. Consequently, he was convinced he acted to defend the Constitution and saw himself as a crusader and hero. This was the worst terrorist event, either domestic or international in origin that had ever occurred in the United States at that time.

In March 1995, four members of the Minnesota Patriots Council, a right-wing militia organization advocating the violent overthrow of the U.S. government, were convicted of conspiracy charges under the Biological Weapons Anti-Terrorism Act of 1989 for planning to use ricin, a lethal biological toxin. The four men allegedly conspired to assassinate federal agents who served papers on one of them for tax violations.

In May 1995, a member of the neo-Nazi organization Aryan Nations was arrested in Ohio on charges of mail fraud. He allegedly misrepresented himself when ordering three vials of freeze-dried Yersinia Pestis, the bacteria that causes bubonic plague, from a Maryland biological laboratory.

In October 1995, the Amtrak Sunset Limited passenger train derailed near Hyder, Arizona. It was determined that the train track had been sabotaged, causing the train to derail and topple 30 feet from a bridge. A letter signed by the Sons of Gestapo was left at the scene. One person was killed and 83 others were injured in this incident.

In November 1995, members of the Tri-States Militia (a group composed of militia from at least 30 states) were arrested after being linked to five would-be terrorists whose bomb plots were thwarted by federal and state law enforcement agencies. The plots involved blowing up the Southern Poverty Law Center, offices of the Anti-Defamation League, federal buildings, abortion clinics, and gay community locations.

In December 1995, an Arkansas man was charged with possession of ricin in violation of the Biological Weapons Anti-Terrorism Act. The man was arrested and subsequently hanged himself in his jail cell the next day.

In July 1996, a pipe bomb exploded in Atlanta’s Centennial Olympic Park as the city was hosting the summer Olympic Games. One person was killed and dozens were wounded. It was later determined that the bomb had been planted by Eric Robert Rudolph, who was also suspected of being responsible for a double bombing at the Sandy Springs Professional Building in Atlanta in January 1997 and a double bombing at the Otherside Lounge in Atlanta in February 1997. Rudolph was arrested in May 2003 after five years on the run. He is a former soldier and survivalist with extreme right-wing views and is also reported to have ties to white supremacist groups.

At about 8:45 a.m. on September 11, 2001, a hijacked commercial airliner struck the North Tower of the World Trade Center in New York City. Shortly after 9:00 a.m., another hijacked aircraft crashed into the South Tower. Approximately 3,000 people were killed in the incident, and about 7,000 more were injured. Emergency responders entered the towers to assist with evacuation of the occupants and perform search and rescue and fire-suppression activities. The towers then collapsed, killing hundreds of responders, including top leaders of the Fire Department of New York City (FDNY) who had been in charge at the scene. A total of 450 responders were killed, including 23 from the New York City Police Department, 343 from FDNY, and 74 from the Port Authority of New York and New Jersey. Approximately 320 emergency responders were treated for injuries or illnesses at five nearby hospitals; others were treated at temporary triage stations. Responders and backup supplies were dispatched from all over the country, including 20 FEMA Urban Search and Rescue (USAR) task forces.

A second attack occurred on September 11, 2001, when a hijacked airliner crashed into the western side of the Pentagon building in Washington, DC, killing 125 people on the ground and 64 people on the plane. Area hospitals treated 88 injured people. The crash damaged or destroyed three of the five interior concentric “rings” of the Pentagon building. The section where the plane hit had been recently renovated and many offices were empty or were being used for storage at the time. Local responders arrived immediately, and other agencies, including

five USAR teams, came to assist. The Arlington County Fire Department set up an incident command system and coordinated the emergency response. The rescue and recovery phase lasted 11 days, and on September 21, Arlington County transferred responsibility for the incident and site management to the FBI. No responders were killed.

Between early October and early December 2001, five people died from anthrax infection, and at least 13 others contracted the disease in Washington, DC; New York City; Trenton, New Jersey; and Boca Raton, Florida. Anthrax spores were found in a number of government buildings and postal facilities in these and other areas. Most of the confirmed anthrax cases were tied to contaminated letters mailed to media personalities and U.S. senators. Thousands of people were potentially exposed to the spores and took preventive antibiotics. Numerous mail facilities and government buildings were shut down for investigation and decontamination.

In the wake of these incidents, federal, state, and local emergency response agencies across the United States responded to thousands of calls to investigate suspicious packages, unknown powders, and other suspected exposures. Almost all of the incidents turned out to involve no actual biohazard. Nevertheless, emergency responders typically treated each call as a potentially serious health and safety risk. During this tense time, in Missouri, the Department of Health and Senior Services (DHSS) issued numerous health alert advisories to local officials and the public, providing guidance on how to handle anthrax or suspicious letters and packages during a time of extremely heightened tensions. DHSS also instituted a surveillance system, contacting health providers to obtain public health information twice weekly, while also working to improve the public health infrastructure, information sharing, health communication networks, and hospital surge capabilities.

Measure of Probability and Severity

Probability: Moderate
Severity: Low to High

The threat of terrorism in the United States remains a concern. Over the past few years, the level of acts committed in the United States has increased steadily. According to the FBI, two known or suspected terrorist acts were recorded in the United States in 1995, 3 in 1996, 4 in 1997, 5 in 1998, and 12 in 1999. In addition to the 12 acts in 1999, an additional 7 planned acts of terrorism were prevented in the United States.

Although several different extremist groups have been identified in Missouri, there have been no indications of any specific recent terrorist activities. The potential does remain, however, for new extremist and/or terrorist groups to move into the state at any time.

An open society such as ours, which depends on technology for its continued smooth operation, remains a potential target for terrorists. Large cities with a variety of news media outlets probably represent the most likely locations for terrorist acts because terrorists generally want their acts to reverberate in the news media and reach the largest audience possible. Since

Missouri does not have large media markets compared to some states, it is not as likely a target for terrorist activity as those other states. However, the Oklahoma City bombing debunked the idea that rural America is completely safe from terrorists.

With this in mind, it appears that a terrorist attack could occur in Missouri; the probability of such an attack is moderate. This is a change from low probability that was noted in the 2004 plan, but the HMPT concurred during a planning team meeting that the probability should be raised to moderate. This probability is not based just on historical incidents in Missouri, but takes into account that the nation has been on a high or elevated threat level since 2001, as discussed in the following paragraphs.

Because of the potential for future terrorist-related incidents, a national security alert system was developed to disseminate information regarding the risk of terrorist acts to federal, state, and local governments and to the American people. This system, known as the Homeland Security Advisory System (HAAS), is based on five color-coded threat conditions, which are summarized in Table 3.51.

Table 3.51. Homeland Security Advisory System Color Codes

Color	Level of Threat	Description
Red	Severe	Severe risk of terrorist attack
Orange	High	High risk of terrorist attack
Yellow	Elevated	Significant risk of terrorist attack
Blue	Guarded	General risk of terrorist attack
Green	Low	Low risk of terrorist attack

Threat conditions are assigned by the secretary of Homeland Security in consultation with the attorney general and other appropriate federal agency heads, including other members of the Homeland Security Council. Threat conditions may be set for the entire nation or a particular geographic area or industrial sector. The assigned threat conditions are reviewed at regular intervals to determine whether adjustments are warranted.

SEMA is currently developing guidelines for implementing the HAAS at the local level, with recommended actions for each threat condition. When completed, those guidelines will be available on SEMA's web site.

Should Missouri experience a terrorist attack, the severity of such an attack could range from high to low depending on the attack. For instance, if a building was blown up and no lives were lost, the severity of the attack would be low. However, if a terrorist group decided to contaminate a large urban area's water supply with a poisonous chemical, the severity of the attack could be very high due to the number of people directly affected by the poisoned water, as well as damage to that community's sense of well-being. An attack of this nature could easily result in mass hysteria and insecurity concerning the government's ability to protect its citizens.

Impact of the Hazard

As stated above, terrorist acts could easily undermine the confidence that people have in their own security and in their government's ability to protect them from harm. For example, instructions to make bombs are readily accessible to potential terrorists (including via the Internet), and the materials for their construction are readily available. Because bombs can be made so easily, the threat of a bomb should not be taken lightly. The threat of a bomb can disrupt a community almost as effectively as an actual bomb, while creating far fewer risks for the persons making the threat. Therefore, no matter how large or small the incident, a terrorist act can have a major impact on a community.

The information in Table 3.52 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.52. EMAP Impact Analysis: Terrorism

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for protected personnel.
Health and Safety of Personnel Responding to the Incident	Adverse impact expected to be severe for unprotected personnel and moderate to light for trained and protected personnel.
Continuity of Operations	Damage to facilities/personnel in the area of the incident may require relocation of operations and lines of succession execution.
Property, Facilities, and Infrastructure	Facilities and infrastructure in the area of the incident may be extensive for explosion, moderate to light for HazMat.
Delivery of Services	Disruption of lines of communication and destruction of facilities may extensively postpone delivery of services.
The Environment	May cause extensive damage, creating denial or delays in the use of some areas. Remediation needed.
Economic and Financial Condition	Local economy and finances adversely affected, possibly for an extended period of time, depending on damage and length of investigation.
Regulatory and Contractual Obligations	Regulatory waivers may be needed. Fulfillment of contracts may be difficult. Demands may overload ability to deliver.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

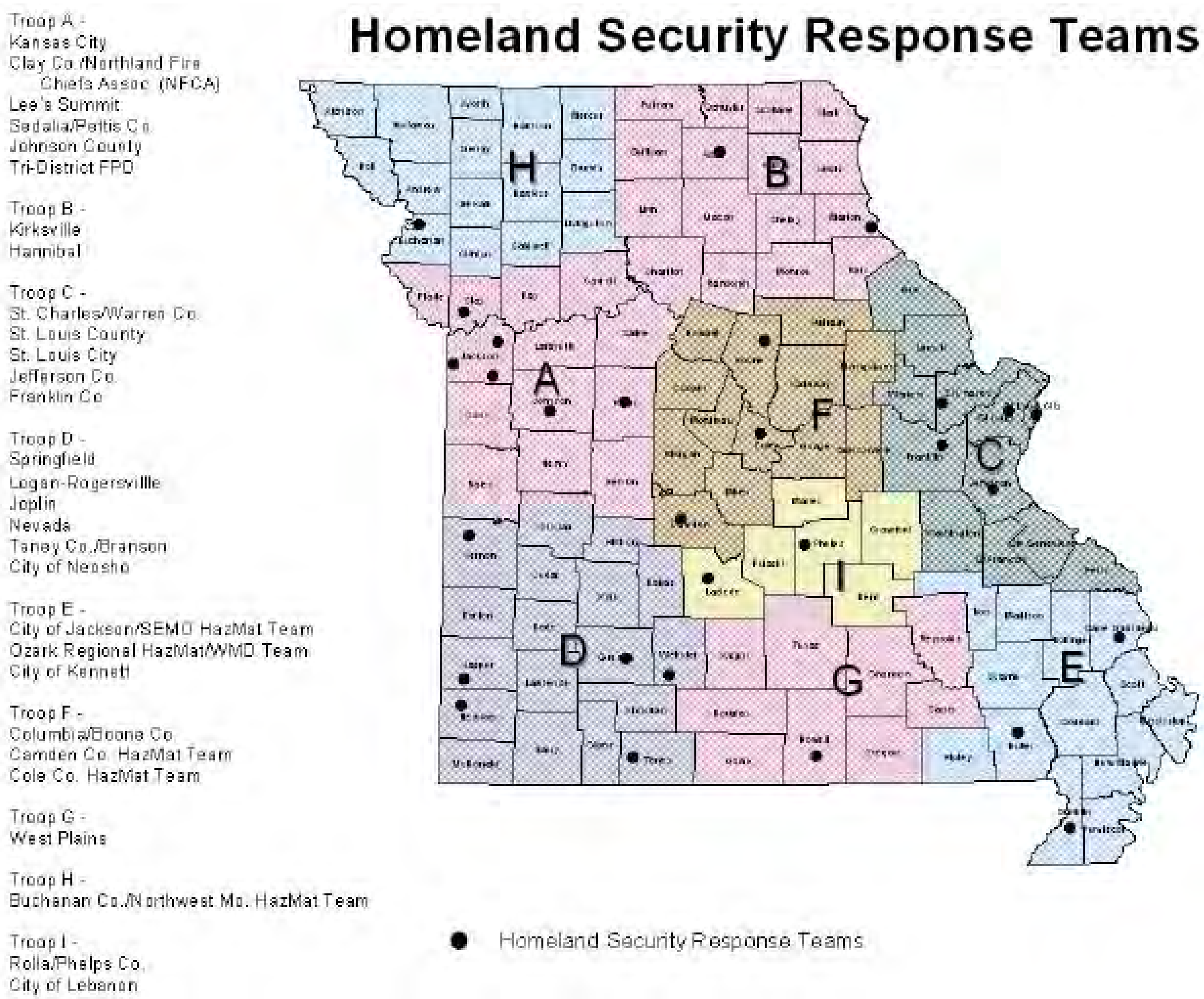
Synopsis

The trend toward high-profile, high-impact attacks has corresponded with growing concerns over the potential use of weapons of mass destruction (WMD). Between 1997 and 2000, the FBI investigated 779 WMD-related reports, generally involving individuals or small groups. The vast majority of these cases were found to be false or fabricated reports. The biological toxin ricin and the bacterial agent anthrax are emerging as the most prevalent agents involved in those investigations. In 2000, 90 of 115 biological threats investigated by the FBI involved threatened use of anthrax. Given the potential for inflicting large-scale injury or death, the efforts of international and domestic terrorists to acquire WMDs remain a significant concern and priority of the FBI.

A terrorist can attack a society in many ways. Therefore, people must prepare for such an incident. In response to these terror threats, Missouri Governor Matt Blunt selected Mark James to be director of the Department of Public Safety. To improve and assist in the homeland security efforts, Governor Blunt signed an executive order formalizing the merger of homeland security responsibilities into the Department of Public Safety. Mr. James will chair a 17-member council made up of directors from other state departments and agencies. These include the State Emergency Management Agency, Department of Health and Senior Services, Department of Transportation, Department of Agriculture, Department of Natural Resources, Department of Economic Development, Missouri State Highway Patrol, Missouri State Water Patrol, Missouri National Guard, Missouri State Fire Marshall, Missouri State Public Service Commission, chief information officer of the state, and three members appointed by the governor. This council will ensure that proper homeland security plans are in place at local and state levels while also examining how homeland security grant funds can best be coordinated and expedited. The council will also prepare an emergency preparedness plan for Governor Blunt's review by January 1, 2006. This plan will include recommendations for structural changes and develop policies and procedures to implement up-to-date response capabilities. It will also recommend improvements to the homeland security grant reimbursement process.

The SEMA Homeland Security Response Teams Map (Figure 3.81) indicates locations of 29 existing or proposed Homeland Security Response Teams for Missouri. A few of these teams include hazardous materials response teams with enhanced capabilities for response to WMD incidents, including incidents involving nuclear or radiological materials and biological and chemical agents. The SEMA Terrorism Program should be contacted to fully determine the capabilities of the Homeland Security Response Teams in specific areas.

Figure 3.81. Missouri's Homeland Security Response Teams



Source: State Emergency Management Agency

3.2.18 Utilities (Interruptions and System Failures)

Description of Hazard

Utility interruptions and failures may involve electrical power, natural gas, public water, and communications systems. All of these systems or a combination of these utility systems exist virtually throughout the state. Many utilities are localized and serve only one community, while other utilities serve a regional area. Utilities are often dispersed over a wide area, and many have facilities located throughout their service area. For example, many electric companies have multiple generating facilities, which can redistribute power via transmission lines as they are connected to load stations. Therefore, power can be redistributed, if needed, so that power is lost to as limited an area as possible. Many water companies have some type of back-up systems

such as water impoundments, other deep wells, or hook-up arrangements with other water companies. Similar switching and rerouting capabilities may exist with communications and natural gas utilities. Utility systems exist everywhere and are subject to damage from digging, fire, traffic accidents, and severe weather, including flooding and other day-to-day events. Many utilities use emergency batteries or generators to provide back-up power for high priority equipment.

Historical Statistics

Because utilities exist everywhere in the state, damage to utilities may occur frequently. This may be due to a backhoe cutting a buried line, an accident involving a motor vehicle, a flood, or other severe weather. Many of these interruptions or failures go unreported to the Public Service Commission (PSC), and no definitive reporting system exists. Therefore, limited statistical information is available.

During the flood of 1993, telecommunications companies proved their adaptability by using cellular service to replace wire line service in areas where service could not be restored in a timely manner. One local exchange company (LEC) used a trailer with cellular pay phones where the land lines were interrupted. Another company temporarily replaced analog subscriber carrier service with site-based cellular service. Short-haul portable microwave was also used to replace copper lines lost during the flood.

On January 30, 2002, a severe ice storm struck portions of western and northern Missouri, leaving devastation and darkened homes and businesses. Many news articles referred to this ice storm as the worst in Missouri’s history. During the ice storm, ice accumulated on any object that was at or below freezing, and the weight of the ice broke utility poles, conductors, tree limbs, and other objects that could not withstand the weight of the ice. Ice accumulations over an inch were reported in many areas. Many tree branches could not withstand the added weight of the ice and fell to the ground, striking whatever was in their path. Cars, homes, streets, properties, and electric power facilities were recipients of the falling trees and limbs. When the ice began to melt, the falling ice caused additional outages. Some electric customers experienced outages more than once during that period, as power was restored but interrupted again by falling limbs.

At the peak of outages, over 400,000 customers were without power. Within three days, most of these customers were returned to service, but many customers in more heavily damaged areas were without power for over a week. Utilities affected by the ice storm quickly mobilized all of their available crews and sought outside assistance. Work crews from 16 different states came to western Missouri in an effort to rapidly restore power to as many customers as possible.

On July 19 and 20, 2006, severe storms with high winds and possible tornado activity struck St. Louis and the counties of St. Louis, Dent, Iron, Jefferson, Oregon, St. Charles, and Washington. As a result of the storms approximately 500,000 AmerenUE customers were without electrical power. Over 3,600 utility workers from AmerenUE and outlying utility companies were involved in restoration efforts, the largest in company history. High priority projects included restoring

power to 14 nursing homes, cooling stations, hospitals, city services, and utility and fuel terminals. Compounding the problems, a heat advisory with heat index values as high as 104°F plagued recovery efforts for several weeks.

Measure of Probability and Severity

Probability: High
Severity: Low

Because utilities exist throughout the state and are vulnerable to interruptions or failures, there is a high probability that this hazard may occur at anytime or anyplace throughout the state. In many cases, these are small isolated events, well within the capabilities of the local utility to address. Therefore, the degree of severity of these day-to-day events may be considered low. Due to long-range planning, regulation, and diligence of the utility operators, major interruptions resulting in a high degree of severity are few and far between. Recent regulatory, planning, and structural initiatives designed to minimize interruptions and failures are listed below.

Impact of the Hazard

Utility outages and interruptions can be very localized or regionwide. Their greatest impact is generally on the very young or elderly, who can be expected to have greater health risks associated with resultant loss of heating/cooling systems and with the loss of medical equipment that requires a power source. Loss of communications can also adversely affect the provision of emergency services, making it difficult to contact the services for emergency assistance. In addition, utility outages can cause significant problems within the financial community, should there be a long-term loss of their data communications.

Communications

In 1990, the telecommunications staff of the PSC requested that LECs submit plans for disaster recovery. Every LEC in the state submitted a plan that lists practices and procedures for any kind of disaster, natural and manmade. The PSC has recommended to the telecommunication industry that in the event of an emergency, the various companies and emergency agencies should coordinate a single point of contact for emergency situations.

In order to mitigate the damage of earthquakes or other disasters, the LECs added bracing to all their central offices for their switching equipment and batteries. Since earthquakes or other disasters may affect electrical service, which is essential for operations, many companies have obtained on-site generators or made contingency arrangements to acquire them in a disaster. For additional information regarding earthquakes in Missouri, see Section 3.2.3 Earthquakes. Such generators would be needed prior to exhaustion of emergency battery supplies, which may last about eight hours.

During the flood of 1993, one LEC provided emergency power to a central office, which was isolated by flood waters. This was accomplished by driving a flat bed truck through the water with a diesel generator mounted on the bed. The generator was fueled by boat.

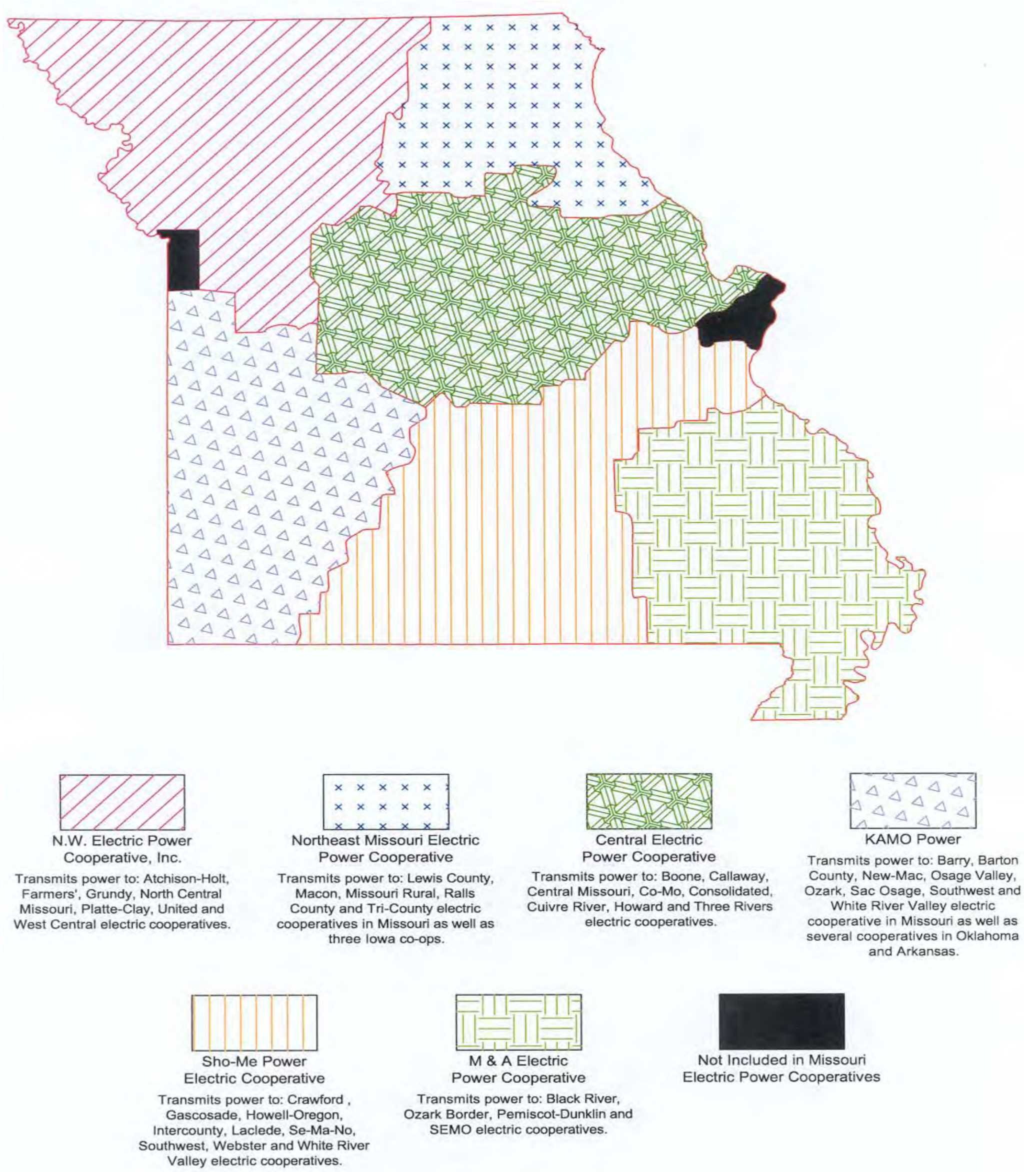
Vulnerability of buried telecommunications cables has always been a problem. Cables may be subject to accidental or intentional cuts. However, legislation and mitigation procedures have been taken to prevent such events. Senate Bills 214 and 264 provided for the existence of a company called “One Call,” which locates and marks buried utilities. Currently, most LECs in the state have their facilities on record with One Call. Anyone planning any subsurface digging, drilling, or plowing of any kind is advised and encouraged to use One Call. Additional steps to prevent cutting of buried telecommunication cables include clearly marking cable routes with above ground pedestals and poles, as well as patrolling the routes by vehicle and air. In addition to these precautions, most companies are presently building fiber rings for the fiber optic routes to protect continuity of service in the event of an accidental cut.

Since floods pose a threat to telephone service, most companies with buried cables in floodplains are replacing conventional telephone pedestals with flood resistant telephone pedestals, which protect the cables during floods of short duration.

Electrical Service

Electrical utilities in Missouri prepare for disasters and power outages by developing written plans to follow when abnormal events cause extensive outages to customers. Power outages caused by severe weather have prompted the creation of tree trimming plans to ensure above ground power lines are free of potential limbs that could fall on power lines and cause interruptions of power if knocked down. In addition, ongoing reviews of emergency plans and training for such events have been implemented. During the 2002 ice storm that struck western and northern Missouri, many customers were unable to contact affected utilities by telephone because there were not enough utility representatives to respond to all customer calls. Therefore, an automated system was developed to allow customers to input information to the computer that automatically generates work orders for service calls. The PSC also advised utility companies to provide feedback to customers that their outage report was recorded.

Figure 3.82. Electrical Cooperatives in Missouri



Natural Gas

All natural gas system operators in the state operate under the jurisdiction of the PSC. These operators must comply with the commission’s pipeline safety regulations, which include emergency response procedures to pipeline emergencies and natural disasters. Natural gas system operators have plans on file with the PSC. Part of these plans includes indexes of utilities and their locations in the state.

In 1989, House Bill 938 provided the commission with additional legal power to enforce the Pipeline Safety Regulations. In 1990, due in part to the Iben Browning earthquake projection, all utilities were mandated by the commission to develop natural disaster plans (to include potential

impacts of earthquakes) and file the plans with the commission. The commission also developed its own plan to respond to a disaster causing an interruption or failure of a utility service. The Iben Browning earthquake projection created a new awareness for the necessity for such disaster response and recovery plans. Several natural gas companies have since stored emergency equipment and survival rations in protected locations. This also resulted in a new demand for excess flow and motion sensing valves on natural gas service lines. Operators also reviewed, updated or increased their mutual aid agreements with other utilities and contractors.

Figure 3.83. Major Interstate Natural Gas Pipelines in Missouri

Source: Energy Information Administration, 1997

In 1990, Senate Bills 214 and 264 required all owners and operators of underground pipeline facilities to participate in the One Call notification center. These bills altered the original Chapter 319 Damage Prevention Act and added a penalty clause. This participation provides for the location of underground pipelines after notification by the excavator and before any excavation work begins.

The information in Table 3.53 is from the Impact Analysis of Potential for Detrimental Impacts of Hazards done for the Emergency Management Accreditation Program.

Table 3.53. EMAP Impact Analysis: Utilities

Subject	Detrimental Impacts
Health and Safety of Persons in the Area at Time of Incident	Localized impact expected to be moderate to severe for special needs population and moderate to light for others.
Health and Safety of Personnel Responding to the Incident	Nature of hazard expected to minimize any serious damage to properly equipped and trained personnel.
Continuity of Operations	Unlikely to necessitate execution of the Continuity of Operations Plan, although some temporary relocation may be needed.
Property, Facilities, and Infrastructure	Impact on facilities and infrastructure dependent upon the nature of the incident (i.e., electric, water, natural gas, communication disruptions).
Delivery of Services	Disruption of utilities may postpone delivery of some services and require repairs to resume services.
The Environment	Localized adverse impact depending on the nature of the incident.
Economic and Financial Condition	Local economy and finances may be adversely affected, depending on damage.
Regulatory and Contractual Obligations	Regulatory waivers may be needed locally. Fulfillment of some contracts may be difficult. Impact may temporarily reduce deliveries.
Reputation of or Confidence in the Entity	Ability to respond and recover may be questioned and challenged if planning, response, and recovery not timely and effective.

Synopsis

Utility companies are generally well prepared to deal with day-to-day outages. The earthquake threat to statewide and multistate utilities is the greatest concern to the integrity and operability of Missouri’s utilities. Severe weather causes more frequent local, and occasionally widespread, utility outages. Manmade incidents, accidental or intentional, could significantly impact utility service. Planning, regulation, mitigation, and mutual aid are all just a few tools available to reduce, speed recovery from, and prevent utility interruptions and failures.

3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction

Requirements §201.4(c)(2)(ii) and §201.4(c)(2)(iii):	[The state risk assessment shall include an] overview and analysis of the state's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments. The state shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. [The state risk assessment shall include an] overview and analysis of potential losses to identified vulnerable structures, based on estimates provided in local risk assessments.
Update §201.4(d):	Plan must be reviewed and revised to reflect changes in development.

According to FEMA's risk assessment guidance (FEMA 386-2) vulnerability is defined as being open to damage or attack. Risk is defined as the possibility of loss or injury. This section details the vulnerability, and risk, that Missouri counties face from the top three hazards identified in the hazards analysis: riverine flooding, tornadoes, and earthquakes. The state prioritized resources toward estimating losses from these significant hazards and in 2007 included a major effort to quantify flood losses statewide using HAZUS-MH, as well as improved tornado and earthquake risk assessments. The plan was improved in 2007 to include flood loss estimations for all counties, as opposed to only seven analyzed in 2004. Attempts to quantify losses for other significant hazards, such as severe winter weather, will be addressed in future plan updates.

This vulnerability analysis identifies the counties most at risk to each of the priority hazards using a variety of methods, including rolling-up information from local hazard mitigation plans, GIS-based risk modeling, and statistical analysis of past historic losses. This section begins with an inventory of the buildings and population that could be vulnerable to hazards within the state followed by an analysis of growth trends, including recent changes in population growth and housing unit development at the county level. New to this plan in 2007 is a summary of the vulnerabilities identified in the local hazard mitigation plans. Also new in 2007 is the integration of nationwide research on populations vulnerable to environmental hazards.

Potential losses were estimated in three ways: GIS modeling, local risk assessments, and statistical analyses using probability and historic damage, annualized to an average value. These methods are described in greater detail in Section 3.3.2 Estimating Potential Losses by Jurisdiction and followed by the results of the loss estimates for the each of the three priority hazards. Potential losses were also rolled up from local plans for each hazard, where available.

Due to the differences in loss estimation methodologies between counties, this detailed loss information is not presented as results could be skewed (i.e., some counties estimated total loss from tornadoes based on total building value exposure, and others used a percentage of the total building value as a representation of loss).

3.3.1 Assessing Vulnerability by Jurisdiction

This section quantifies the population and buildings exposed to potential hazards, by county. Tables 3.54 and 3.55 provide numeric breakdowns of this information that form the basis of the vulnerability and risk assessment presented in this plan. This information was derived from inventory data associated with FEMA's loss estimation software HAZUS-MH MR 2 (May 2006). Building inventory counts are based on the 2000 census data adjusted to 2002 numbers using the Dun & Bradstreet Business Population Report. Inventory values reflect 2005 valuations, based on RSMeans (a supplier of construction cost information) replacement costs. Population counts are 2005 estimates from the U.S. Census Bureau. This table replaces an earlier HAZUS-MH inventory presented in the 2004 version of this plan.

Table 3.54. Population and Building Count

County	Estimated Population (2005)	Building Count (HAZUS-MH)							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Adair	24,509	7,167	120	4	5	9	4	9	7,318
Andrew	16,899	5,510	35	1	2	2	1	0	5,551
Atchison	6,246	2,075	20	0	5	2	1	0	2,103
Audrain	25,759	8,318	67	18	9			0	8,422
Barry	35,599	12,069	116	32	6	13	3	0	12,239
Barton	13,057	4,129	31	3	2	1	1	0	4,167
Bates	17,027	5,547	42	2	8	2	1	0	5,602
Benton	18,854	9,042	43	6	5	10	3	0	9,109
Bollinger	12,325	4,385	17	0	1	5	1	0	4,409
Boone	143,326	38,079	599	47	8	37	24	8	38,802
Buchanan	84,904	25,839	359	47	0	19	7	0	26,271
Butler	41,338	13,543	205	23	10	14	8	2	13,805
Caldwell	9,307	3,009	6	0	0	0	0	0	3,015
Callaway	42,541	13,264	59	4	1	3	4	1	13,336
Camden	39,432	22,407	218	27	0	12	7	0	22,671
Cape Girardeau	71,161	21,081	310	27	1	16	9	2	21,446
Carroll	10,193	3,597	23	10	7	2	22	0	3,661
Carter	5,910	2,342	17	4	0	3	3	0	2,369
Cass	94,232	26,004	151	17	3	10	3	1	26,189
Cedar	14,160	5,025	45	1	3	4	0	0	5,078
Chariton	8,124	3,247	20	2	8	3	0	0	3,280
Christian	67,266	17,235	78	24	0	5	1	0	17,343
Clark	7,323	2,741	12	1	5	1	1	0	2,761
Clay	202,078	55,758	644	78	1	42	11	1	56,535
Clinton	20,715	6,239	31	4	1	2	5	0	6,282
Cole	72,757	20,749	272	23	0	26	166	0	21,236
Cooper	17,294	5,057	59	2	1	3	2	0	5,124
Crawford	23,932	8,428	54	2	0	5	1	0	8,490
Dade	7,830	2,899	8	1	2	1	2	0	2,913
Dallas	16,437	5,371	46	2	2	2	3	0	5,426

County	Estimated Population (2005)	Building Count (HAZUS-MH)							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Daviess	8,121	2,878	13	13	1	1	1	0	2,907
DeKalb	12,342	2,780	28	0	2	0	5	0	2,815
Dent	15,083	5,314	46	8	2	8	2	0	5,380
Douglas	13,594	4,576	25	0	1	1	0	0	4,603
Dunklin	32,545	10,438	75	9	1	5	2	0	10,530
Franklin	99,090	31,167	238	65	0	21	4	4	31,499
Gasconade	15,745	6,015	33	12	1	5	1	0	6,067
Gentry	6,555	2,239	20	1	4	0	4	0	2,268
Greene	250,784	71,961	1,258	100	1	73	30	10	73,433
Grundy	10,327	3,516	26	1	3	5	2	0	3,553
Harrison	8,876	3,085	22	0	1	1	0	0	3,109
Henry	22,577	7,557	63	8	0	4	5	0	7,637
Hickory	9,271	4,883	19	0	0	3	2	0	4,907
Holt	5,081	2,109	18	0	6	2	1	0	2,136
Howard	9,957	3,411	14	0	0	1	0	0	3,426
Howell	38,400	12,021	115	11	0	6	5	0	12,158
Iron	10,273	3,782	21	5	0	7	1	0	3,816
Jackson	662,959	189,194	3,103	376	10	176	106	5	192,970
Jasper	110,624	32,603	414	85	3	20	9	3	33,137
Jefferson	213,669	19,336	146	10	0	4	7	0	19,503
Johnson	50,784	13,810	109	18	2	14	19	65	14,037
Knox	4,171	1,646	9	1	6	3	0	0	1,665
Laclede	34,492	10,864	99	39	0	11	3	0	11,016
Lafayette	33,108	10,613	98	6	12	7	1	0	10,737
Lawrence	37,127	11,096	70	17	10	16	2		11,211
Lewis	10,186	3,372	15	0	6	3	2	0	3,398
Lincoln	47,727	13,447	57	5	1	2	0	0	13,512
Linn	13,133	4,726	26	7	5	3	5	0	4,772
Livingston	14,291	4,603	53	4	3	2	1	0	4,666
Macon	15,600	5,584	24	2	1	3	4	0	5,618
Madison	12,151	4,218	30	10	1	5	1	0	4,265
Maries	8,989	3,288	15	2	2	3	1	0	3,311

County	Estimated Population (2005)	Building Count (HAZUS-MH)							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Marion	28,375	8,700	103	16	2	8	12	1	8,842
McDonald	22,844	7,092	36	12	6	4	2	0	7,152
Mercer	3,595	1,559	8	0	2	1	1	0	1,571
Miller	24,712	8,397	56	9	1	5	2	0	8,470
Mississippi	13,599	4,177	21	3	3	4	1	0	4,209
Moniteau	15,084	4,440	19	7	2	5	6	0	4,479
Monroe	9,379	3,581	19	2	5	0	0	0	3,607
Montgomery	12,166	4,676	32	7	6	2	1	0	4,724
Morgan	20,436	10,941	57	5	2	4	2	0	11,011
New Madrid	18,566	6,214	48	5	3	4	2	0	6,276
Newton	55,554	17,471	131	24	2	8	4	3	17,643
Nodaway	21,710	6,038	71	16	13	7	5	0	6,150
Oregon	10,403	3,681	26	3	2	6	1	0	3,719
Osage	13,485	4,717	21	31	6	0	2	4	4,781
Ozark	9,490	4,119	19	2	1	3	1	0	4,145
Pemiscot	19,412	5,987	41	3	31	7	5	0	6,074
Perry	18,571	6,176	75	18	5	14	2	0	6,290
Pettis	40,121	12,161	147	33	3	0	3	1	12,348
Phelps	42,125	12,387	112	5	0	11	12	1	12,528
Pike	18,762	5,672	66	2	4	4	6	0	5,754
Platte	82,085	21,593	179	13	1	8	4	1	21,799
Polk	28,892	8,557	63	4	6	5	1	2	8,638
Pulaski	44,187	11,358	114	6	2	14	19	0	11,513
Putnam	5,168	2,048	9	1	2	1	1	0	2,062
Ralls	9,761	3,707	14	1	3	3	1	0	3,729
Randolph	25,336	8,057	88	28	4	5	7	1	8,190
Ray	24,101	7,603	20	8	1	1	1	0	7,634
Reynolds	6,585	2,930	12	6	0	3	2	0	2,953
Ripley	13,851	4,906	30	13	1	3	0	0	4,953
Saline	23,075	7,452	74	12	11	6	6	0	7,561
Schuyler	4,308	1,421	10	0	7	0	1	0	1,439
Scotland	4,928	1,685	15	2	6	0	1	0	1,709

County	Estimated Population (2005)	Building Count (HAZUS-MH)							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Scott	41,143	12,762	116	16	5	9	7	0	12,915
Shannon	8,367	2,723	10	2	0	2	0	0	2,738
Shelby	6,744	2,384	12	5	4	3	1	0	2,409
St. Charles	329,940	84,577	784	97	0	45	38	17	85,558
St. Clair	9,686	3,983	25	0	2	2	1	0	4,013
St. Francois	61,661	17,166	151	14	0	4	10	0	17,345
St. Louis	1,004,666	307,131	4,843	793	14	305	78	18	313,182
St. Louis City	344,362	84,736	1,623	260	0	103	85	20	86,827
Ste. Genevieve	18,198	6,369	47	18	0	3	2	0	6,439
Stoddard	29,714	9,814	85	5	0	2	0	0	9,906
Stone	30,931	12,551	87	15	0	15	3	0	12,671
Sullivan	6,907	2,490	24	1	4	1	1	0	2,521
Taney	42,985	13,491	290	6	1	16	7	0	13,811
Texas	24,614	7,916	59	14	0	10	8	0	8,007
Vernon	20,441	6,602	58	19	8	4	1	0	6,692
Warren	28,764	9,339	45	7	1	8	3	0	9,403
Washington	24,032	7,762	26	5	0	12	6	0	7,811
Wayne	13,097	5,941	27	6	0	8	0	0	5,982
Webster	34,745	9,528	60	18	56	8	1	0	9,671
Worth	2,174	881	4	0	2	0	0	0	887
Wright	18,306	5,931	43	0	1	5	0	0	5,980

Sources: U.S. Census Bureau, 2006b; HAZUS-MH MR2

Table 3.55. Estimated Values for the Key Occupancies (Uses) for the State of Missouri (2005 Valuations)*

County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Adair	$947,201	$197,233	$17,131	$12,530	$22,812	$4,036	$54,077	$1,255,020
Andrew	$759,949	$75,620	$8,988	$6,763	$8,333	$1,340	$4,540	$865,533
Atchison	$247,722	$49,709	$5,229	$12,004	$5,687	$713	$4,656	$325,720
Audrain	$1,060,536	$192,845	$65,282	$19,652	$12,861	$9,116	$7,870	$1,368,162
Barry	$1,128,147	$216,592	$92,000	$15,335	$31,156	$3,119	$8,401	$1,494,750
Barton	$437,572	$76,898	$11,986	$5,108	$2,588	$1,913	$4,500	$540,565
Bates	$607,993	$84,962	$22,599	$19,025	$6,352	$1,047	$756	$742,734
Benton	$825,309	$93,153	$19,499	$9,763	$22,353	$2,439	$3,610	$976,126
Bollinger	$411,097	$50,066	$8,670	$6,853	$11,999	$1,860	$7,334	$497,879
Boone	$6,228,237	$1,285,203	$150,019	$27,833	$94,038	$26,442	$101,024	$7,912,796
Buchanan	$3,971,438	$900,530	$185,306	$9,593	$59,484	$9,029	$17,311	$5,152,691
Butler	$1,378,963	$367,830	$56,814	$22,164	$27,769	$7,959	$22,458	$1,883,957
Caldwell	$337,512	$24,481	$2,367	$6,411	$4,615	$469	$5,276	$381,131
Callaway	$1,611,234	$162,883	$24,262	$7,589	$15,350	$6,348	$21,148	$1,848,814
Camden	$3,077,711	$406,226	$74,277	$3,981	$29,073	$7,786	$13,457	$3,612,511
Cape Girardeau	$3,261,501	$629,293	$87,756	$9,270	$43,975	$11,127	$28,610	$4,071,532
Carroll	$417,456	$63,391	$23,636	$17,669	$4,554	$22,898	$6,785	$556,389
Carter	$213,432	$24,190	$11,642	$1,857	$7,528	$2,723	$8,501	$269,873
Cass	$4,230,985	$337,075	$68,568	$15,449	$24,665	$4,214	$11,300	$4,692,256
Cedar	$506,952	$90,453	$13,627	$8,226	$13,432	$568	$1,797	$635,055
Chariton	$370,383	$57,259	$11,868	$15,354	$7,610	$742	$2,749	$465,965
Christian	$2,104,222	$209,264	$74,025	$4,377	$16,051	$1,567	$2,424	$2,411,930
Clark	$277,526	$33,640	$4,285	$9,733	$2,640	$882	$3,691	$332,397
Clay	$10,567,047	$1,709,719	$292,302	$15,303	$130,555	$17,393	$33,849	$12,766,168
Clinton	$968,607	$87,122	$17,114	$9,317	$8,397	$5,531	$3,652	$1,099,740
Cole	$3,334,146	$610,821	$84,142	$6,568	$71,650	$170,016	$25,312	$4,302,655
Cooper	$626,262	$133,278	$11,993	$5,447	$11,574	$2,598	$6,009	$797,161
Crawford	$939,565	$117,431	$22,662	$4,759	$16,004	$2,709	$13,856	$1,116,986
Dade	$279,133	$28,489	$11,037	$6,451	$5,700	$1,661	$5,670	$338,141
Dallas	$489,457	$77,400	$11,354	$5,988	$8,722	$3,108	$9,300	$605,329
Daviess	$321,511	$34,816	$30,939	$5,725	$4,578	$887	$2,516	$400,972

County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
DeKalb	$348,348	$57,393	$2,839	$5,688	$4,323	$5,264	$0	$423,855
Dent	$534,308	$104,038	$24,762	$5,617	$18,649	$2,347	$6,613	$696,334
Douglas	$420,573	$45,724	$1,817	$1,584	$3,346	$936	$1,535	$475,515
Dunklin	$1,015,663	$165,820	$27,641	$10,651	$17,870	$3,435	$6,471	$1,247,551
Franklin	$4,318,184	$557,516	$198,256	$8,773	$60,071	$5,545	$46,016	$5,194,361
Gasconade	$683,787	$93,641	$33,651	$6,692	$12,909	$1,145	$7,055	$838,880
Gentry	$272,400	$52,862	$6,032	$8,409	$4,029	$4,289	$3,804	$351,825
Greene	$10,545,327	$2,524,694	$322,058	$23,289	$173,573	$32,324	$106,806	$13,728,071
Grundy	$415,647	$66,363	$4,541	$6,407	$8,822	$1,945	$7,267	$510,992
Harrison	$369,234	$54,285	$3,294	$6,879	$5,844	$249	$5,703	$445,488
Henry	$914,663	$176,001	$41,192	$6,433	$15,125	$8,438	$11,470	$1,173,322
Hickory	$371,534	$34,260	$5,080	$3,341	$6,082	$2,182	$2,957	$425,436
Holt	$219,759	$33,910	$3,720	$10,872	$4,631	$1,402	$0	$274,294
Howard	$385,194	$33,214	$6,540	$4,070	$5,566	$753	$4,280	$439,617
Howell	$1,141,505	$253,193	$36,256	$6,310	$22,769	$8,045	$9,488	$1,477,566
Iron	$386,442	$42,036	$11,569	$1,520	$13,156	$732	$136	$455,591
Jackson	$35,387,349	$7,562,801	$1,263,440	$53,367	$487,872	$132,605	$196,461	$45,083,895
Jasper	$4,034,325	$892,048	$224,572	$15,668	$52,382	$10,624	$43,500	$5,273,119
Jefferson	$9,153,311	$1,004,260	$250,295	$13,837	$89,150	$11,939	$109,907	$10,632,699
Johnson	$2,009,070	$248,804	$54,588	$10,595	$36,458	$22,927	$429,723	$2,812,165
Knox	$180,473	$21,962	$4,083	$12,493	$4,573	$399	$3,648	$227,631
Laclede	$1,120,862	$226,736	$116,990	$5,825	$26,747	$2,878	$9,562	$1,509,600
Lafayette	$1,497,911	$247,785	$29,990	$27,676	$21,534	$2,682	$13,122	$1,840,700
Lawrence	$1,184,391	$170,605	$52,448	$22,643	$33,435	$2,643	$8,872	$1,475,037
Lewis	$363,477	$36,461	$4,092	$10,441	$6,399	$1,560	$364	$422,794
Lincoln	$1,576,187	$163,116	$22,363	$6,507	$14,063	$332	$2,810	$1,785,378
Linn	$507,719	$78,717	$19,496	$13,134	$12,176	$3,356	$6,671	$641,269
Livingston	$573,939	$104,778	$13,868	$7,594	$5,911	$2,562	$5,778	$714,430
Macon	$595,266	$82,118	$12,238	$3,845	$8,922	$5,407	$2,468	$710,264
Madison	$426,598	$73,073	$29,554	$4,804	$12,562	$1,886	$4,136	$552,613
Maries	$324,917	$33,342	$13,419	$7,052	$4,315	$1,006	$3,681	$387,732
Marion	$1,239,554	$223,421	$50,438	$10,277	$20,871	$12,524	$10,033	$1,567,118
McDonald	$594,996	$64,903	$32,909	$12,742	$12,563	$2,242	$8,912	$729,267

County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Mercer	$164,573	$19,445	$2,847	$4,372	$2,619	$1,113	$1,383	$196,352
Miller	$916,870	$121,717	$31,397	$6,702	$12,328	$1,508	$6,646	$1,097,168
Mississippi	$485,186	$53,090	$8,940	$7,388	$8,906	$1,017	$2,533	$567,060
Moniteau	$549,680	$54,678	$27,668	$7,546	$12,266	$6,424	$3,660	$661,922
Monroe	$340,763	$35,540	$7,642	$10,979	$3,909	$191	$4,033	$403,057
Montgomery	$549,790	$84,035	$20,068	$14,084	$6,245	$2,104	$4,654	$680,980
Morgan	$1,046,796	$168,845	$26,083	$7,708	$16,129	$2,675	$3,354	$1,271,590
New Madrid	$660,347	$132,608	$15,917	$10,823	$12,978	$1,784	$15,940	$850,397
Newton	$1,897,764	$310,683	$65,812	$9,493	$25,480	$4,454	$40,279	$2,353,965
Nodaway	$864,688	$142,813	$48,204	$22,126	$16,886	$4,696	$13,539	$1,112,952
Oregon	$315,778	$52,545	$8,040	$4,951	$9,239	$1,466	$2,582	$394,601
Osage	$585,335	$67,415	$83,566	$12,206	$4,532	$1,941	$30,524	$785,519
Ozark	$328,185	$45,222	$15,617	$3,625	$4,242	$555	$1,922	$399,368
Pemiscot	$611,415	$94,323	$12,253	$60,579	$14,659	$5,894	$8,463	$807,586
Perry	$788,719	$156,194	$86,700	$14,341	$35,287	$3,518	$3,729	$1,088,488
Pettis	$1,590,718	$375,289	$111,117	$12,555	$12,466	$5,068	$20,224	$2,127,437
Phelps	$1,570,360	$241,122	$35,220	$4,444	$31,106	$13,042	$21,592	$1,916,886
Pike	$668,229	$118,951	$18,256	$14,481	$12,387	$7,009	$10,743	$850,056
Platte	$4,330,640	$441,756	$76,277	$7,668	$26,435	$5,450	$20,094	$4,908,320
Polk	$910,392	$151,351	$32,062	$17,689	$18,165	$727	$16,311	$1,146,697
Pulaski	$1,745,376	$216,994	$22,790	$4,428	$34,179	$16,998	$15,925	$2,056,690
Putnam	$200,140	$22,338	$4,590	$5,029	$3,469	$720	$469	$236,755
Ralls	$412,633	$38,037	$5,836	$7,615	$5,036	$1,492	$2,513	$473,162
Randolph	$944,885	$200,114	$70,834	$9,717	$16,005	$8,254	$14,100	$1,263,909
Ray	$1,081,798	$78,844	$44,222	$4,787	$13,561	$3,101	$4,448	$1,230,761
Reynolds	$291,137	$23,382	$13,916	$1,511	$7,056	$2,093	$2,807	$341,902
Ripley	$394,568	$60,915	$36,503	$3,069	$6,896	$674	$4,224	$506,849
Saline	$1,003,442	$168,826	$44,305	$22,151	$17,311	$7,212	$12,947	$1,276,194
Schuyler	$146,568	$21,018	$2,499	$12,071	$2,076	$1,462	$3,190	$188,884
Scotland	$174,630	$34,792	$9,703	$10,342	$2,625	$1,736	$1,757	$235,585
Scott	$1,521,041	$307,117	$64,530	$19,910	$26,759	$7,691	$11,559	$1,958,607
Shannon	$262,526	$25,864	$5,012	$2,850	$4,426	$282	$286	$301,246
Shelby	$259,336	$33,050	$18,120	$9,690	$7,371	$1,113	$5,042	$333,722

County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
St. Charles	$15,141,811	$1,825,178	$350,274	$25,723	$123,824	$42,754	$166,212	$17,675,776
St. Clair	$359,614	$54,597	$4,671	$6,434	$6,305	$2,060	$1,404	$435,085
St. Francois	$2,250,051	$404,690	$52,823	$7,597	$26,668	$12,023	$12,065	$2,765,917
St. Louis	$59,112,260	$12,246,054	$2,496,099	$98,016	$768,178	$102,634	$416,519	$75,239,760
St. Louis City	$17,827,055	$3,811,427	$922,760	$7,563	$273,531	$107,414	$259,365	$23,209,115
Ste. Genevieve	$831,040	$123,692	$56,699	$5,418	$10,193	$3,252	$2,581	$1,032,875
Stoddard	$1,052,801	$167,870	$23,430	$4,432	$14,993	$2,099	$965	$1,266,590
Stone	$1,241,059	$156,774	$36,494	$4,630	$28,069	$2,732	$10,934	$1,480,692
Sullivan	$257,925	$40,361	$3,440	$8,349	$4,979	$1,350	$2,789	$319,193
Taney	$1,588,574	$496,122	$38,118	$5,336	$34,724	$9,062	$10,850	$2,182,786
Texas	$784,999	$137,804	$41,637	$9,170	$26,021	$7,374	$9,670	$1,016,675
Vernon	$810,559	$123,443	$46,171	$14,055	$11,811	$2,031	$4,311	$1,012,381
Warren	$1,167,657	$113,332	$37,912	$5,115	$22,161	$2,837	$9,944	$1,358,958
Washington	$686,131	$65,751	$15,282	$3,497	$26,533	$5,496	$1,915	$804,605
Wayne	$503,894	$61,109	$23,744	$3,183	$18,112	$892	$5,182	$616,116
Webster	$1,020,096	$139,538	$50,465	$106,574	$19,249	$1,896	$7,776	$1,345,594
Worth	$101,124	$11,667	$2,919	$3,660	$1,538	$637	$366	$121,911
Wright	$569,028	$102,429	$10,189	$7,987	$17,808	$1,168	$15,335	$723,944
Total	$267,971,705	$48,138,503	$9,735,083	$1,374,801	$3,826,534	$1,060,018	$2,771,343	$334,877,987

Source: HAZUS-MH MR2
Note:
*All $ values are in thousands

Assessing Vulnerability: Growth and Development

As part of the plan update process, the state looked at changes in growth and development and examined these changes in the context of the state's hazard-prone areas and how the changes in growth and development affect loss estimates and vulnerability. When the population in a hazardous area increases, so does the vulnerability of people and property associated with the hazards unless mitigation measures are taken.

When this plan was originally developed, local hazard mitigation plans were not available. As part of the update process, the state reviewed baseline information from the original local hazard mitigation plans, paying particular attention to the high-growth counties. Since these plans were first generation plans, trend information beyond baseline data (e.g., population, land area) was generally not discussed. Notable and important development trends illustrated in future local hazard mitigation plan updates (e.g., changes in land use in hazardous areas, mitigation successes), where discussed, will be captured in future state plan updates. The discussion here focuses on population growth and increases in housing units and density by county, based on U.S. Census Bureau data.

Population

In 2006, Missouri ranked 18th among the 50 states in population, 25th in rate of growth, 18th in land area, and 28th in population density (assuming land area in 2006 was the same as it was in 2000, which was 68,886 square miles). In 1830, the first year of statehood, Missouri had a population of 140,455. Decennial census findings from the last few decades illustrate Missouri's growth (see Table 3.56).

Table 3.56. Missouri's Population Growth

Census	Total Population	Percent Change
1970	4,677,623	
1980	4,917,444	5.13%
1990	5,117,073	4.06%
2000	5,595,211	9.34%

U.S. Census Bureau estimates place Missouri's 2006 population at 5,842,713. This reflects an increase of 4.4 percent between 2000 and 2006. County estimates for 2006 were not yet available when this plan was updated in 2007, so most data presented here will use 2005 population estimates for the state (5,800,310) as well as the counties. Figure 3.84 illustrates Missouri's population by county.

Figure 3.84. Counties by Population (Estimated), 2005

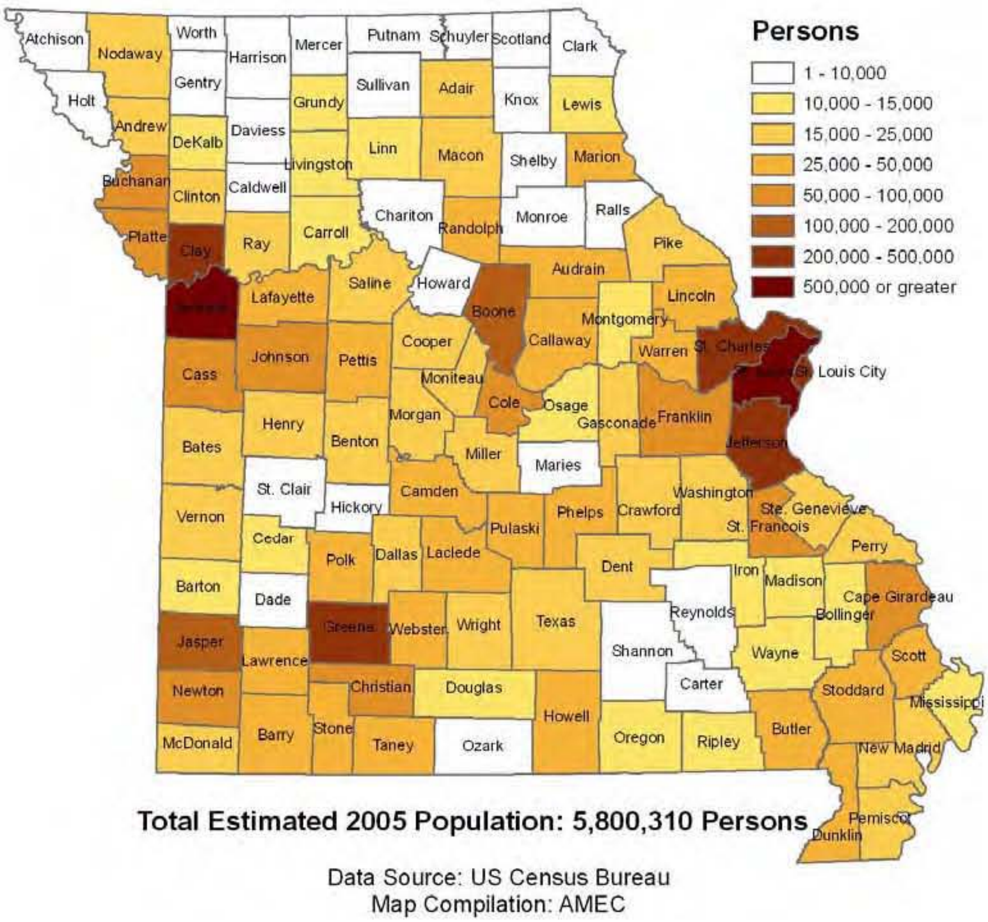


Table 3.57. Missouri Quick Facts

Missouri Population	5,800,310
Area Square Miles (2000)*	68,886
Persons per Square Mile	84.2
Number of Incorporated Cities, Towns, and Villages*	948
Number of Counties**	115
Urban/Rural Population (2000)*	69.4 %/30.6 %
Population in Metropolitan Area (2000)*	67.8 %
Cities with a Population of 50,000 or More**	12
Counties with a Population Greater than 500,000	2 (St. Louis, Jackson)
Counties with a Population of 200,000 to 500,000**	5 (St. Louis City, St. Charles, Greene, Jefferson, Clay)
Counties with a Population of 100,000 to 200,000	2 (Boone, Jasper)
Counties with a Population of 50,000 to 100,000	10
Counties with a Population of 25,000 to 50,000	23
Counties with a Population of 15,000 to 25,000	28
Counties with a Population of 10,000 to 15,000	18
Counties with a Population of 1 to 10,000	27

Sources: U.S. Census Bureau, 2001a, 2001b, 2006b, 2006c, 2006j
Notes:
*2000 data are used where more recent information is not available from the U.S. Census Bureau
**St. Louis City is considered both a “place” and a “county” by the U.S. Census Bureau, so it is treated here as a county as well as a city

Between 2000 and 2005, 78 counties gained population, 29 of which (25 percent of all counties) gained more than 5 percent. This growth was concentrated primarily in the St. Louis and Kansas City metropolitan areas and in the southwest quarter of the state. The majority of the remaining growth took place south of I-70. According to Missouri’s Office of Social and Economic Analysis (OSEDA), 57 percent of the increase is attributed to the number of births exceeding the number of deaths, and 43 percent is attributed to in-migration (OSEDA 2006).

The metropolitan counties experienced the greatest numerical gains between 2000 and 2005. The population gain in the 10 counties with the greatest gains (all metropolitan counties) totaled 148,251, nearly three-fourths (72 percent) of the state’s estimated total population increase from 2000–2005. Nevertheless, these counties only represent 36 percent of Missouri’s estimated total 2005 population. Of the counties with the largest gains or most rapid increases, six of them (Jackson, St. Charles, Greene, Jefferson, Clay, and Boone) also rank among Missouri’s 10 most populous counties, and six of them (St. Charles, Clay, Christian, Cass, Lincoln, and Platte) rank in both the top 10 number of people gained as well as percent gained.

While St. Louis and Jackson counties are two of the 100 most populous counties in the nation (Census 2006i), Christian and Lincoln counties, ranked 58th and 73rd respectively, are two of the nation’s 100 fastest growing counties (of those counties with populations greater than 10,000) in terms of population (Census 2006h). Located between Springfield and the Branson/Tri-Lakes area, Christian County attributes its growth to the growth of the tourism and recreation economies and transportation system improvements (Southwest Missouri 2005).

Lincoln and Warren counties, part of the St. Louis metropolitan area, attribute their growth to their proximity to the St. Louis metropolitan area. They also credit improved transportation routes, telecommunications, low-cost housing and transportation, and the fear of crime and urban decay associated with the metropolitan area's more urban areas (Etcher et al. 2003).

Growth in Missouri counties over the past few decades has also been attributed to a robust national and regional economy that led to low unemployment and reasonable interest rates. Although these growth factors have been dampened by the recent economic slowdown, not every county has been affected to the same extent. A report from the Brookings Institution suggests that Missouri is decentralizing and that the state's land consumption is increasing (Brookings 2002). Both of these trends are important for Missouri to monitor as it means more developed land area and buildings may require hazard mitigation.

Table 3.58 lists Missouri's 10 most populous counties. Tables 3.59 and 3.60 list the counties that have grown the most by number of people and percent respectively. Figures 3.85 and 3.86 illustrate population changes statewide.

Table 3.58. Top 10 Counties Ranked by Population (Estimated), 2005

County	2005 Population
St. Louis	1,004,666
Jackson	662,959
St. Louis City*	348,189
St. Charles	329,940
Greene	250,784
Jefferson	213,669
Clay	202,078
Boone	143,326
Jasper	110,624
Franklin	99,090

Source: U.S. Census Bureau, 2006b
Note:
*St. Louis City is considered both a "place" and a "county" by the U.S. Census Bureau, so it is treated here as a county as well as a city

Table 3.59. Counties with Greatest Estimated Population Gains (Numerical), 2000-2005

County	Population Gain 2000-2005
St. Charles	46,057
Clay	18,072
Jefferson	15,570
Christian	12,981
Cass	12,140
Greene	10,393
Lincoln	8,783
Platte	8,304
Jackson	8,079
Boone	7,872
Total	**148,251**

Source: U.S. Census Bureau, 2006b

Table 3.60. Counties with Greatest Estimated Population Gains (Percent), 2000-2005

County	Population Gain (%) 2000-2005
Christian	23.91 %
Lincoln	22.55 %
Warren	17.28 %
St. Charles	16.22 %
Cass	14.79 %
Webster	11.92 %
Platte	11.25 %
St. Francois	10.82 %
Clay	9.82 %
Benton	9.74 %

Source: U.S. Census Bureau, 2006b

Figure 3.85. Estimated Change in Population by County, 2000-2005

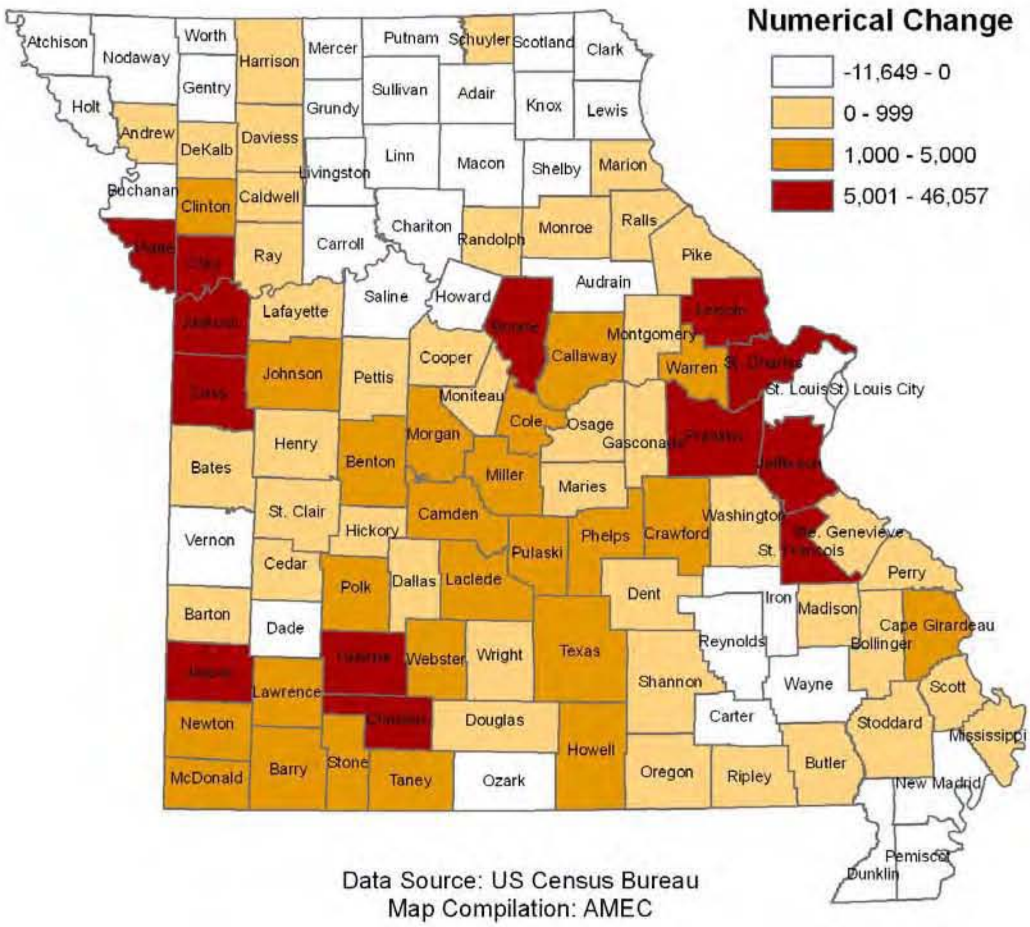
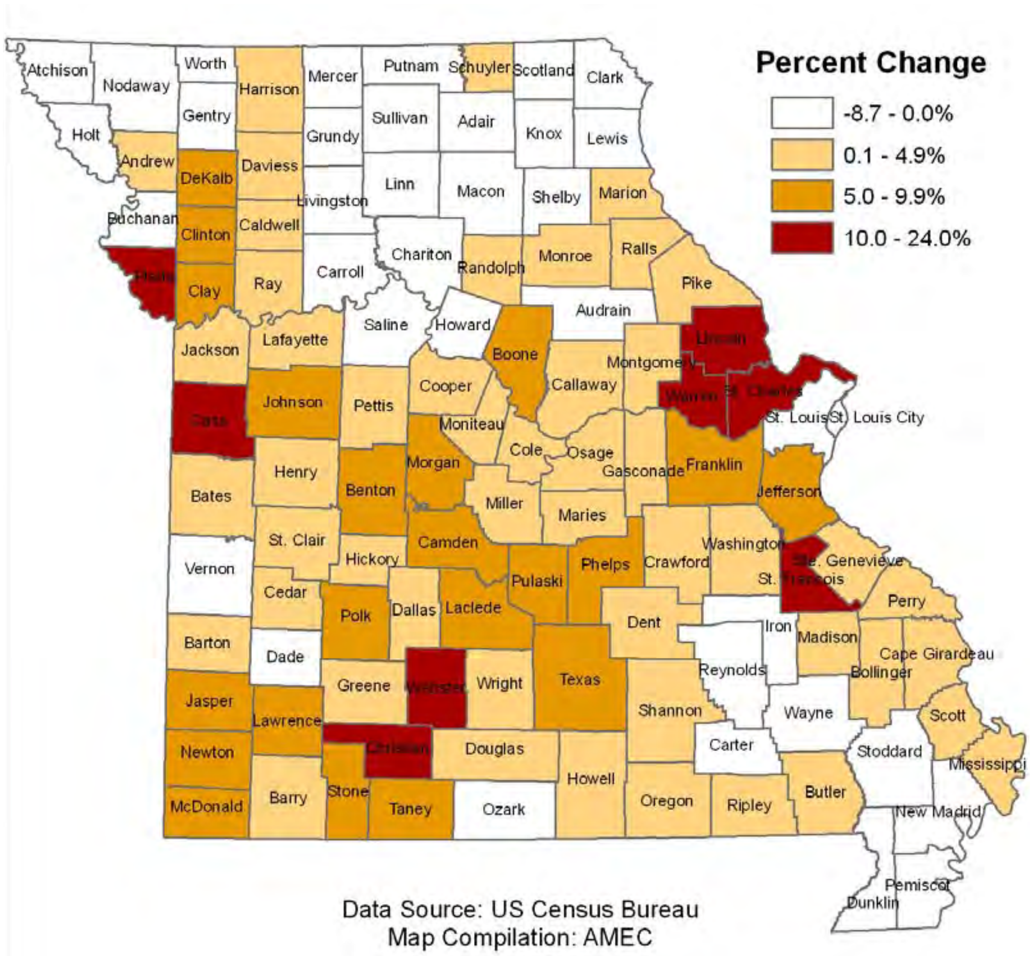


Figure 3.86. Estimated Percent Change in Population by County, 2000-2005



Not all of Missouri's counties are growing, however (refer back to Figures 3.85 and 3.86 and see Tables 3.61 and 3.62). Two of the most populous counties (St. Louis County and St. Louis City) also lost the greatest number of people. Of the counties with the greatest or most rapid losses, 5 of them (Worth, Mercer, Knox, Holt, and Gentry) also rank among Missouri's 10 least populous counties (see Table 3.63). Three of them (New Madrid, Linn, and Iron) rank in the top 10 by number of people lost as well as percent lost.

Table 3.61. Counties with Greatest Estimated Population Losses (Numerical), 2000-2005

County	Population Loss 2000-2005
St. Louis	-11,649
St. Louis City*	-3,827
New Madrid	-1,194
Buchanan	-1,094
Saline	-681
Pemiscot	-635
Linn	-621
Dunklin	-610
Adair	-468
Iron	-424

Source: U.S. Census Bureau, 2006b
Note:
*St. Louis City is considered both a "place" and a "county" by the U.S. Census Bureau, so it is treated here as a county as well as a city

Table 3.62. Counties with Greatest Estimated Population Losses (Percent), 2000-2005

County	Population Loss (%) 2000-2005
Worth	-8.73%
New Madrid	-6.04%
Holt	-5.05%
Linn	-4.52%
Gentry	-4.46%
Knox	-4.36%
Sullivan	-4.32%
Mercer	-4.31%
Iron	-3.96%
Chariton	-3.72%

Source: U.S. Census Bureau, 2006b

Table 3.63. Ten Smallest Counties Ranked by Population (Estimated), 2005

County	2005 Population
Worth	2,174
Mercer	3,595
Knox	4,171
Schuyler	4,308
Scotland	4,928
Holt	5,081
Putnam	5,168
Carter	5,910
Atchison	6,246
Gentry	6,555

Source: U.S. Census Bureau, 2006b

Interim population projections issued by the U.S. Census Bureau in 2005 suggest that Missouri's population will continue to grow, but percentages will drop, over the next three decades (see Table 3.64). Population projections are only at the state level. Projections by county based on the 2000 census are not currently available.

Table 3.64. Interim Missouri Population Projections, 2005-2030

Year	Estimated Population	Percent Change
2005*	5,765,166	
2010	5,922,078	2.72%
2015	6,069,556	2.49%
2020	6,199,882	2.15%
2025	6,315,366	1.86%
2030	6,430,173	1.82%

Source: U.S. Census Bureau, 2005
Note:
*Estimate issued in 2005 (5,800,310 is current estimate, projections have not been updated)

Appendix B Demographics contains population information for all Missouri counties and the incorporated areas identified by the U.S. Census Bureau. It also contains information about per capita personal income for the counties from the Bureau of Economic Analysis.

Housing Units

Another indicator of growth is number of housing units. The census defines a housing unit as a house, an apartment, a mobile home or trailer, a group of rooms, or a single room that is occupied, or, if vacant, is intended for occupancy as separate living quarters. According to the U.S. Census Bureau, the number of estimated housing units in Missouri increased 6.2 percent (150,806 units) between 2000 and 2005. Missouri ranked 17th among the 50 states in number of housing units. Christian County again topped the list for percent growth and was the 92nd fastest growing county (in terms of housing units) in the nation between 2000 and 2005 (Census 2006g).

Tables 3.65 and 3.66 list the counties that have grown the most in terms of housing units by number and percent respectively. Figures 3.87 and 3.88 illustrate these changes statewide.

Table 3.65. Counties with Greatest Estimated Housing Unit Gains (Numerical), 2000-2005

County	Housing Unit Gains 2000-2005
St. Charles	21,795
Jackson	19,469
Greene	11,075
St. Louis	8,737
Boone	8,605
Jefferson	7,986
Clay	6,408
Cass	5,114
Christian	4,764
Platte	4,029

Source: U.S. Census Bureau, 2006a

Table 3.66. Counties with Greatest Estimated Housing Unit Gains (Percent), 2000-2005

County	Housing Unit Gains (%) 2000-2005
Christian	21.83%
St. Charles	20.66%
Warren	18.33%
Cass	16.14%
Boone	15.18%
Taney	13.98%
Platte	13.04%
Greene	10.60%
Jefferson	10.57%
Clinton	10.42%

Source: U.S. Census Bureau, 2006a

Figure 3.87. Estimated Change in Housing Units by County, 2000-2005

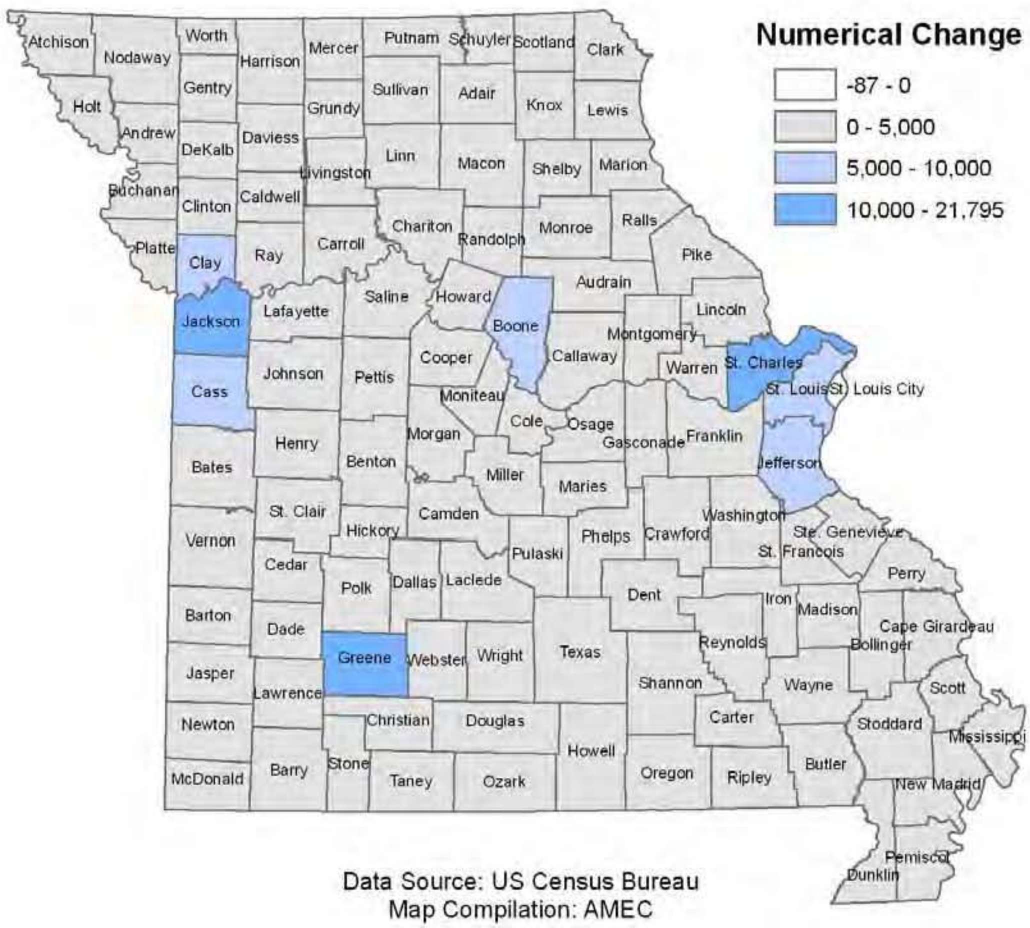
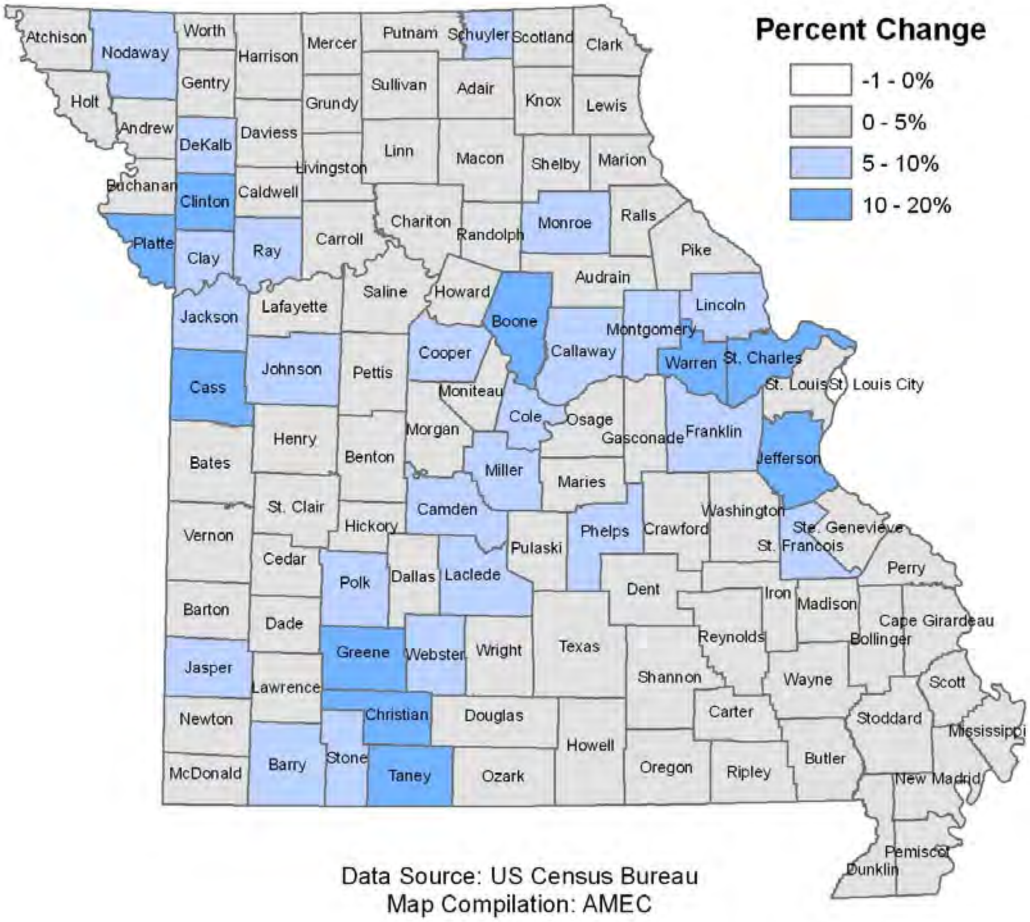


Figure 3.88. Estimated Percent Change in Housing Units by County, 2000-2005



As illustrated in Table 3.67, the 10 most populous counties (Table 3.57) also have the most housing units. Housing unit growth also tracks with population growth, but not quite as closely.

Table 3.67. Top 10 Counties Ranked by Number of Housing Units (Estimated), 2005

County	2005 Housing Units
St. Louis	432,486
Jackson	307,700
St. Louis City	176,267
St. Charles	127,309
Greene	115,592
Jefferson	83,572
Clay	82,638
Boone	65,283
Jasper	48,363
Franklin	41,583

Source: U.S. Census Bureau, 2006a

Density

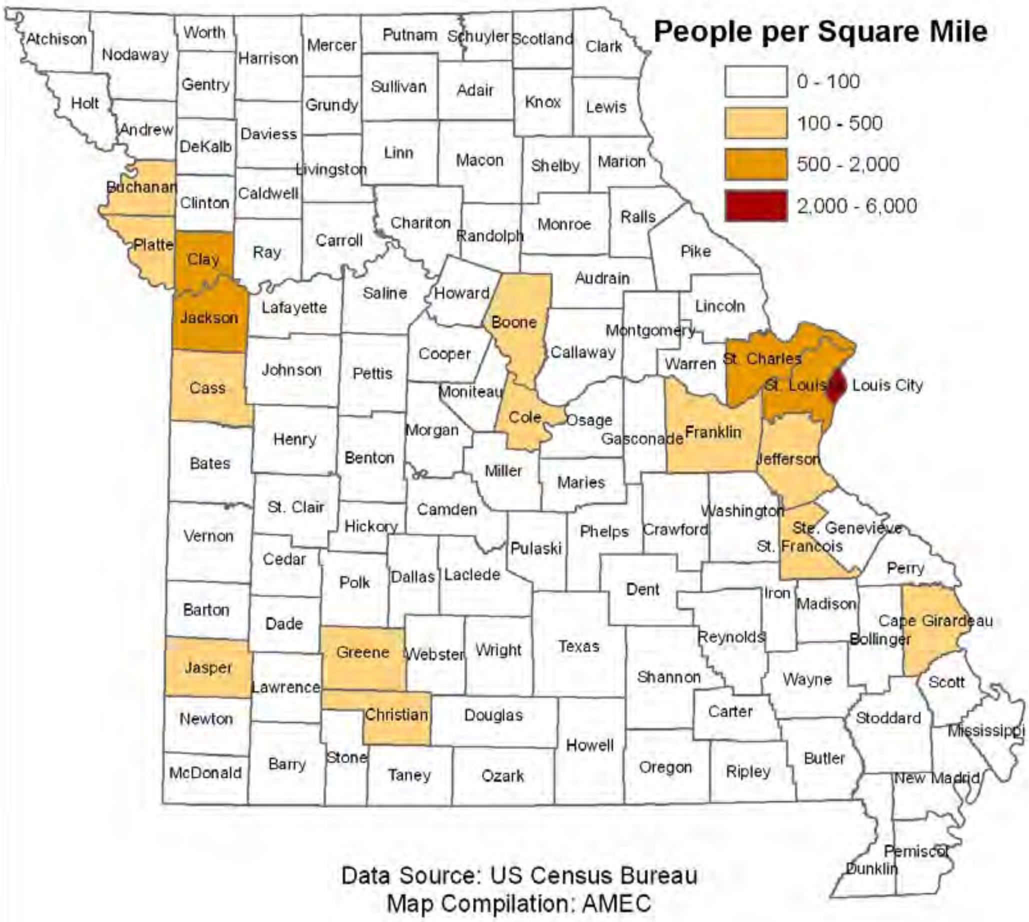
Missouri has a surface land area of 68,886 square miles (2000 census) and a population of 5,800,310 (2005 census estimate). Based on the 2005 census estimates, Missouri ranked 28th in population density and 27th in housing density among the 50 states. The same 10 counties ranked at the top in terms of both population density and housing density (see Table 3.68). Eight of these counties (excluding Buchanan and Platte) also ranked among Missouri's top 10 most populous counties. Figure 3.89 illustrates density by county statewide.

Table 3.68. Top 10 Counties Ranked by Population/Housing Density, 2005

County	2005 Estimated Population Density*	Population Density* Change (%) 2000-2005	2005 Estimated Housing Density*	Housing Density* Change (%) 2000-2005
St. Louis City**	5,561.4	-1.10%	2,846.7	-0.05%
St. Louis	1,978.4	-1.15%	851.7	2.06%
Jackson	1,096.1	1.23%	508.7	6.75%
St. Charles	588.7	16.22%	227.2	20.66%
Clay	509.8	9.82%	208.5	8.41%
Greene	371.5	4.32%	171.3	10.60%
Jefferson	325.3	7.86%	127.2	10.57%
Boone	209.1	5.81%	95.2	15.18%
Buchanan	207.2	-1.27%	91.5	2.52%
Platte	195.3	11.25%	83.1	13.04%

Sources: U.S. Census Bureau, 2001a, 2006a, 2006c
Notes:
*Density is reported as people/housing units per square mile and is based on the square mileage of the counties in the 2000 census
**St. Louis City is considered both a "place" and a "county" by the U.S. Census Bureau, so it is treated here as a county as well as a city

Figure 3.89. Population Density by County, 2005



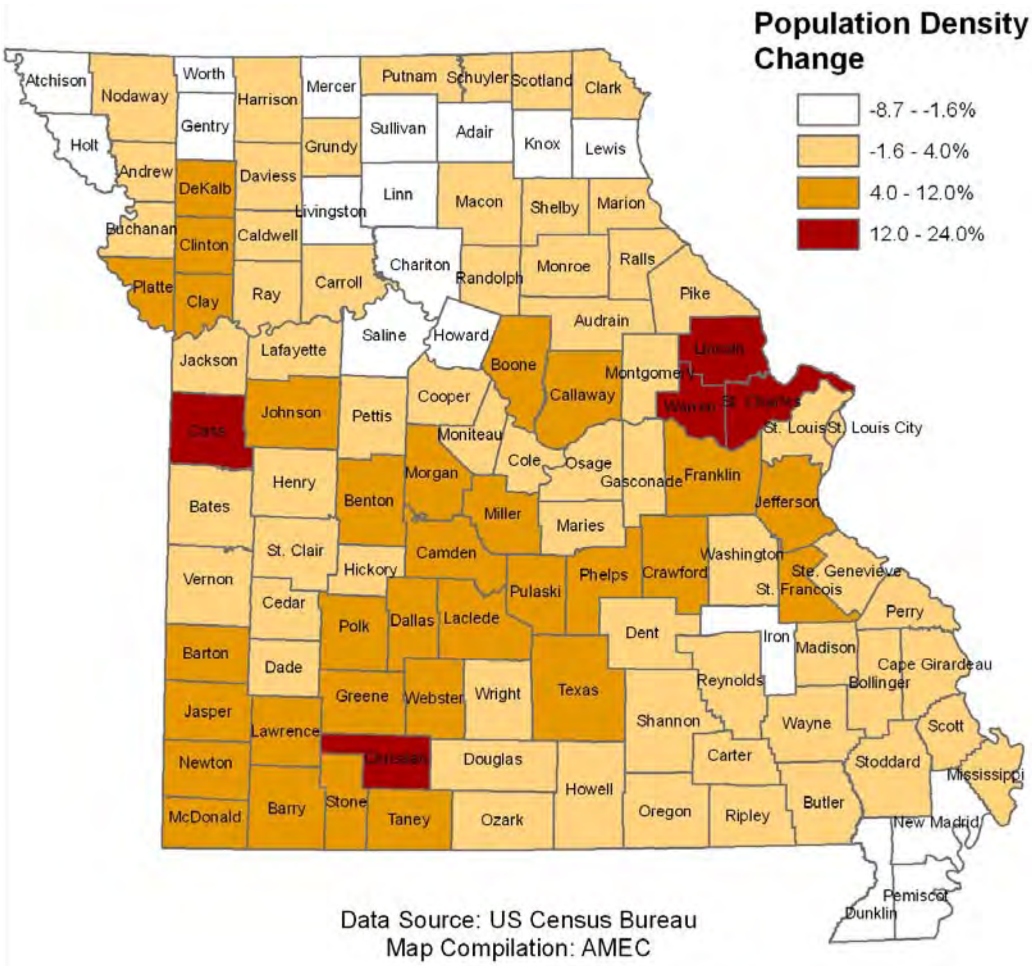
The percent change in population density tracks with the percent change in population growth. The fastest growing counties are also seeing their population density increase more rapidly than the other counties (see Table 3.69 and Figure 3.90).

Table 3.69. Counties with Greatest Estimated Population Density Gains (Percent), 2000-2005

County	Population Density* Gains (%) 2000-2005
Christian	23.9%
Lincoln	22.6%
Warren	17.3%
St. Charles	16.2%
Cass	14.8%
Webster	11.9%
Platte	11.3%
St. Francois	10.8%
Clay	9.8%
Benton	9.7%

Sources: U.S. Census Bureau, 2001a, 2006a, 2006c
Note:
*Density is reported as people per square mile and is based on the square mileage of the counties in the 2000 census.

Figure 3.90. Estimated Percent Change in Population Density by County, 2000-2005



Summary of Impact of Growth and Development Trends on Vulnerability and Loss Estimates

In general, counties with growing populations and number of housing units will have increased vulnerability to random events such as tornadoes and winter storms. Population growth is factored into the tornado risk assessment methodology that follows in Section 3.3.4. Extreme southeastern Missouri counties are experiencing little (less than 5 percent) or no growth, thus the earthquake vulnerability to those populations has not changed significantly between 2000 and 2005. Growth in population and housing units in St. Charles means that earthquake loss estimations from HAZUS-MH in Section 3.3.5 will likely be underestimated as HAZUS-MH inventory is based on 2000 population and 2002 building counts. The counties experiencing the most development pressures all participate in the National Flood Insurance Program, thus flood risk should not be increasing, assuming that county floodplain ordinances are being effectively implemented and wise use of floodplains is being encouraged.

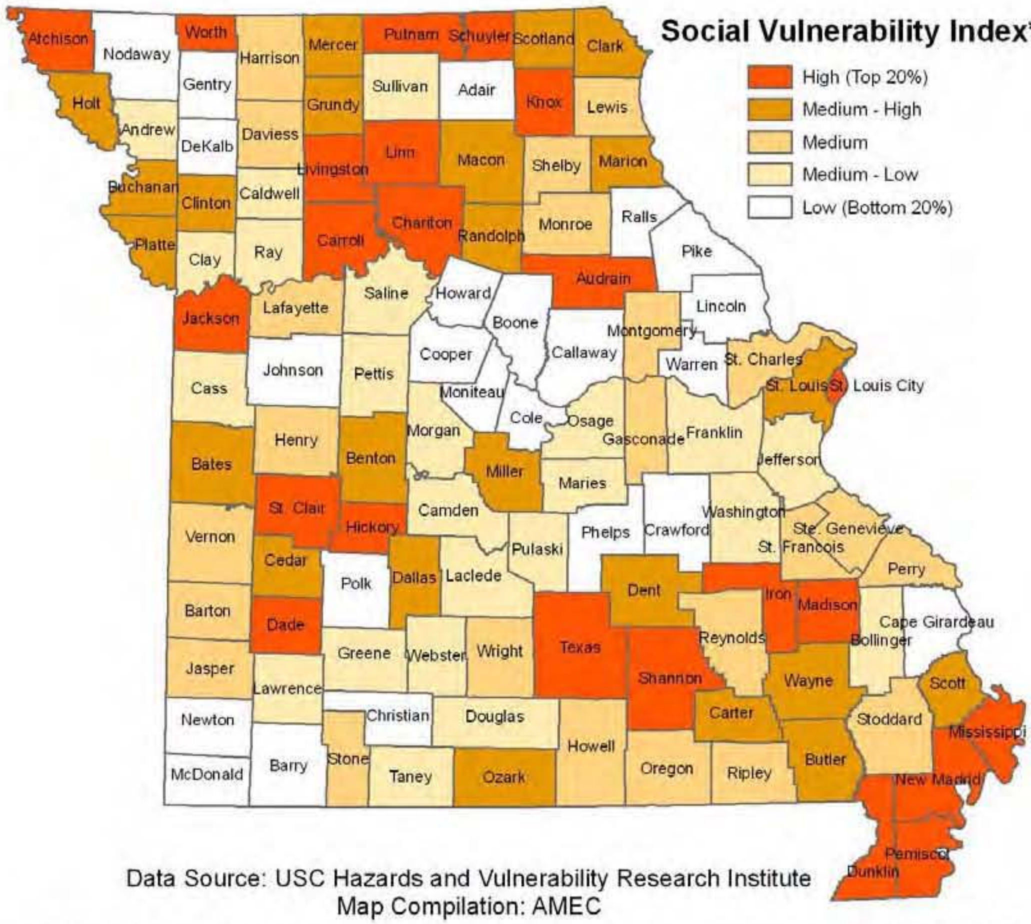
Social Vulnerability

A Social Vulnerability Index compiled by the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina measures the social vulnerability of U.S. counties to environmental hazards for the purpose of examining the differences in social vulnerability among counties. Based on national data sources, primarily the 2000 census, it synthesizes 42 socioeconomic and built environment variables that research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards (i.e., social vulnerability). Eleven composite factors were identified that differentiate counties according to their relative level of social vulnerability: personal wealth, age, density of the built environment, single-sector economic dependence, housing stock and tenancy, race (African American and Asian), ethnicity (Hispanic and Native American), occupation, and infrastructure dependence.

The index can be used by the state to help determine where social vulnerability and exposure to hazards overlaps and how and where mitigation resources might best be used. See Figure 3.91 for a map that illustrates Missouri's geographic variation in social vulnerability. According to the index, the following, listed in order, are Missouri's most vulnerable counties (i.e., they rank in the top 20 percent in the state—and the nation): Pemiscot, Texas, Mississippi, Hickory, Shannon, St. Louis City, Worth, Carroll, Linn, Chariton, Atchison, Knox, Putnam, New Madrid, Madison, St. Clair, Livingston, Schuyler, Dunklin, Audrain, Jackson, Dade, and Iron.

The counties of Cedar, Mercer, and Carter are close behind and also rank in the top 20 percent in the nation.

Figure 3.91. Social Vulnerability to Environmental Hazards, County Comparison within the State, 2000



*The Social Vulnerability Index is a composite of the following factors: personal wealth, age, density of the built environment, single-sector economic dependence, housing stock and tenancy, race, ethnicity, occupation, and infrastructure dependence.

Local Plan Vulnerability Assessments

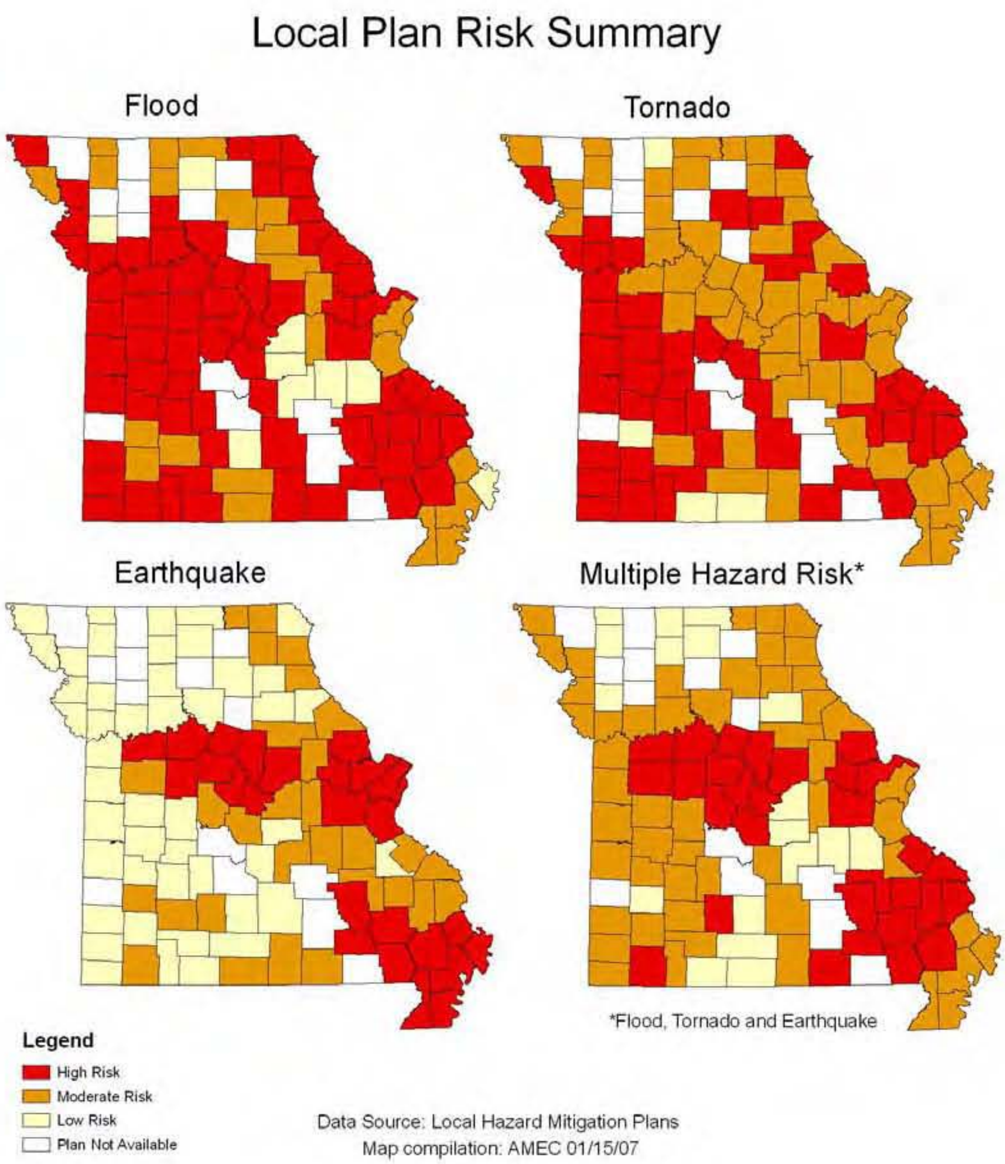
As of February 2007, 94 county-level plans in Missouri had been approved by the Federal Emergency Management Agency. This gave the state the opportunity to review the local risk assessments to help the state better understand its vulnerability in terms of the jurisdictions most threatened by hazards.

In its analysis, the state was interested in how the local governments ranked the hazards in their jurisdictions and the potential losses (i.e., people, buildings, and dollar values) associated with the hazards of greatest concern (local plans only considered natural hazards). Where available, the state extracted the "Ranking of Adverse Impact on Community" information from the "Hazard Identification and Analysis" table. This ranking factor is based on a combination of probability, severity, and extent of the hazard and was determined to be the best measure of overall risk in the plans. This ranking was either numeric or described in terms of high, medium, or low. In cases where this information was not available, rankings were determined from other factors such as risk priority and severity.

To properly analyze and summarize the data, a common scale was required. During the review of the local plan risk assessments, all rankings of adverse impact were converted to a High, Moderate, Low scale. In most instances, the original ranking was done on a 1-5 scale, with 5 being High, 3-4 being Moderate, and 1-2 being Low. However, other scales were also employed and documented during the process. In addition to the risk summary, the number of persons, buildings, and building value at risk to the high and moderate hazards were captured. All information was summarized to the county level.

Since the state prioritized riverine flooding, tornadoes, and earthquakes as its hazards of greatest concern, the analysis focused on these hazards to see if local governments concurred. The analysis does show that floods, tornadoes, and earthquakes are also the highest priority hazards from the local perspective, closely followed by severe winter weather. Figure 3.92 shows which counties are particularly concerned about these hazards individually and which counties are concerned about multiple hazards (floods, tornadoes, and earthquakes). The multiple hazard risk analysis displays the counties that have a high risk to more than one hazard.

Figure 3.92. Local Plan Risk Summary



Multiple hazard risk counties are shown in red in Figure 3.92 and listed alphabetically below:

Barry	Howard	Perry
Bollinger	Iron	Pettis
Boone	Johnson	Reynolds
Butler	Lafayette	Saline
Callaway	Lincoln	St. Charles
Cape Girardeau	Madison	Ste. Genevieve
Carter	Miller	Stoddard
Cole	Moniteau	Warren
Cooper	Morgan	Wayne
Franklin	Oregon	Webster

The local risk assessment summary allowed for an analysis of where hazards other than floods, tornadoes, and earthquakes are of high concern to particular counties. Table 3.70 lists all the hazards and the number of counties that ranked them at each of the scale levels: High, Moderate, and Low. The data suggests that severe winter weather rivals the top three in terms of concern and, in fact, is a more widespread concern than earthquakes.

Table 3.70. Local Risk Assessment Hazards Ranking Summary (Ranked by Number of Highs)

Hazard*	High	Moderate	Low
Riverine Flooding	69	25	9
Tornadoes**	46	53	4
Thunderstorms**	35	46	1
Earthquakes	26	30	47
Severe Winter Weather	25	62	14
Drought***	9	45	48
Fires****	7	29	60
Dam Failure	7	25	65
Heat Wave***	6	40	48

Notes:
*Not all plans ranked all hazards
**Most plans included thunderstorms with tornadoes
***Some plans combined drought and heat wave
****Most plans did not differentiate type of fires (i.e., urban fire, structural, or wildfire)

Table 3.71 shows the rankings each county assigned these hazards. Other hazards ranked included land subsidence (1 High), lightning (7 Lows), and landslides (2 Lows).

Table 3.71. Hazards Rankings by County

County	Dam Failure	Drought	Earthquake	Fires (structural, urban and wild)	Heat Wave	Riverine Flooding (Major and Flash)	Severe Winter Weather	Thunderstorms	Tornadoes	Other	
Adair											
Andrew	low	mod	low	low	low	high	mod	mod	mod	low	Landslide
Atchison	low	high	low	low	n/a	high	mod	mod	mod	n/a	
Audrain	low	low	mod	mod	low	mod	high	n/a	high	n/a	
Barry	low	low	mod	low	low	high	high	high	high	n/a	
Barton											
Bates	high	low	low	mod	mod	high	mod	high	high	n/a	
Benton	mod	low	low	mod	mod	high	mod	high	high	n/a	
Bollinger	low	low	mod	low	low	high	mod	high	high	n/a	
Boone	low	low	high	mod	n/a	high	mod	n/a	mod	n/a	
Buchanan	low	mod	low	low	low	high	mod	mod	mod	low	Landslide
Butler	mod	mod	high	low	low	high	mod	n/a	high	n/a	
Caldwell											
Callaway	low	low	high	mod	n/a	high	mod	mod	mod	n/a	
Camden											
Cape Girardeau	low	low	mod	low	low	high	mod	high	high	n/a	
Carroll	low	mod	low	low	mod	high	mod	mod	mod	low	Lightning
Carter	mod	mod	high	low	low	high	mod	n/a	high	n/a	
Cass	low	mod	low	low	mod	high	mod	n/a	high	n/a	
Cedar	mod	low	low	mod	mod	high	mod	high	high	n/a	
Chariton	low	high	low	mod	mod	high	mod	mod	mod	low	Lightning
Christian	low	mod	low	low	mod	high	high	high	high	n/a	
Clark	low	mod	low	low	mod	high	high	high	high	n/a	
Clay	mod	mod	low	low	mod	high	mod	n/a	high	n/a	
Clinton	low	mod	low	low	mod	low	mod	mod	high	n/a	
Cole	low	low	high	mod	n/a	high	mod	mod	mod	n/a	
Cooper	low	low	high	mod	n/a	high	mod	n/a	mod	n/a	
Crawford	low	low	mod	low	low	low	low	mod	mod	n/a	
Dade	low	low	mod	mod	low	mod	n/a	mod	low	n/a	
Dallas	low	low	low	low	low	high	high	high	high	n/a	
Daviess											
DeKalb											
Dent											
Douglas	low	low	low	low	low	mod	mod	mod	mod	n/a	
Dunklin	n/a	low	high	n/a	low	mod	mod	mod	mod	n/a	
Franklin	high	high	high	low	mod	high	high	n/a	high	n/a	
Gasconade	low	low	mod	low	low	mod	low	mod	mod	n/a	
Gentry	low	mod	low	low	n/a	mod	mod	mod	mod	n/a	

County	Dam Failure	Drought	Earthquake	Fires (structural, urban and wild)	Heat Wave	Riverine Flooding (Major and Flash)	Severe Winter Weather	Thunderstorms	Tornadoes	Other	
Greene	low	mod	mod	mod	mod	mod	mod	mod	mod	high	Land Subsidence
Grundy	low	high	low	mod	high	mod	high	mod	mod	low	Lightning
Harrison											
Henry	mod	low	low	mod	mod	high	mod	high	high	n/a	
Hickory	mod	low	low	mod	mod	high	mod	high	high	n/a	
Holt	low	mod	low	low	high	mod	high	high	high	n/a	
Howard	low	low	high	mod	n/a	high	mod	n/a	mod	n/a	
Howell	low	low	mod	low	mod	high	high	mod	mod	n/a	
Iron	low	low	mod	low	low	high	mod	high	high	n/a	
Jackson	mod	mod	low	low	high	high	mod	n/a	high	n/a	
Jasper	high	high	low	high	mod	high	mod	high	high	n/a	
Jefferson	mod	mod	high	mod	low	mod	mod	n/a	mod	n/a	
Johnson	mod	mod	mod	mod	mod	high	high	high	high	n/a	
Knox	low	low	mod	low	low	high	low	mod	mod	n/a	
Laclede											
Lafayette	mod	low	high	high	low	high	mod	mod	mod	n/a	
Lawrence	low	low	low	low	low	mod	high	high	high	n/a	
Lewis	low	low	mod	low	low	high	low	mod	mod	n/a	
Lincoln	high	low	high	mod	low	high	low	high	high	n/a	
Linn											
Livingston	low	high	low	mod	high	high	high	mod	mod	low	Lightning
Macon	low	mod	low	mod	mod	mod	high	high	high	n/a	
Madison	low	low	mod	low	low	high	mod	high	high	n/a	
Maries	low	low	low	low	low	low	low	mod	mod	n/a	
Marion	low	mod	mod	low	mod	high	high	mod	mod	n/a	
McDonald	high	high	low	high	mod	high	mod	high	high	n/a	
Mercer	low	mod	low	low	mod	mod	mod	mod	low	low	Lightning
Miller	mod	mod	mod	n/a	mod	high	high	n/a	high	n/a	
Mississippi	n/a	low	high	n/a	low	low	low	mod	mod	n/a	
Moniteau	low	low	high	mod	n/a	high	mod	n/a	mod	n/a	
Monroe	low	high	low	mod	high	mod	high	mod	mod	n/a	
Montgomery	mod	low	mod	low	low	mod	low	mod	mod	n/a	
Morgan	mod	n/a	mod	mod	mod	high	high	n/a	high	n/a	
New Madrid	n/a	mod	high	n/a	mod	mod	low	mod	mod	n/a	
Newton	high	high	low	high	mod	high	mod	high	high	n/a	
Nodaway											
Oregon	low	mod	mod	mod	low	high	high	high	high	n/a	
Osage	low	low	mod	low	low	low	mod	mod	mod	n/a	
Ozark	low	mod	mod	low	mod	mod	high	low	low	n/a	

County	Dam Failure	Drought	Earthquake	Fires (structural, urban and wild)	Heat Wave	Riverine Flooding (Major and Flash)	Severe Winter Weather	Thunderstorms	Tornadoes	Other	
Pemiscot	n/a	mod	high	n/a	mod	mod	low	mod	mod	n/a	
Perry	low	low	mod	low	low	high	mod	high	high	n/a	
Pettis	mod	low	high	high	low	high	mod	mod	mod	n/a	
Phelps	low	low	mod	low	low	low	mod	mod	mod	n/a	
Pike	low	mod	mod	low	mod	high	high	mod	mod	n/a	
Platte	low	mod	low	low	low	high	mod	n/a	high	n/a	
Polk	low	low	low	low	low	high	high	high	high	n/a	
Pulaski	low	mod	low	low	low	high	mod	high	high	n/a	
Putnam	low	mod	low	low	mod	mod	mod	mod	mod	low	Lightning
Ralls	mod	mod	low	low	mod	high	mod	high	high	n/a	
Randolph											
Ray	low	mod	low	low	low	high	mod	n/a	high	n/a	
Reynolds	mod	mod	high	low	low	high	mod	n/a	mod	n/a	
Ripley	mod	mod	low	mod	low	high	mod	mod	mod	n/a	
Saline	mod	mod	high	high	mod	high	mod	mod	mod	n/a	
Schuyler	low	low	mod	low	low	high	low	mod	mod	n/a	
Scotland	low	low	mod	low	low	high	low	mod	mod	n/a	
Scott	n/a	low	high	n/a	low	mod	low	mod	mod	n/a	
Shannon	low	mod	mod	low	mod	mod	high	mod	mod	n/a	
Shelby	low	mod	low	mod	mod	mod	high	high	high	n/a	
St. Charles	mod	mod	high	low	mod	high	mod	n/a	mod	n/a	
St. Clair	mod	low	low	mod	mod	high	mod	high	high	n/a	
St. Francois	low	low	low	low	low	high	mod	high	high	n/a	
St. Louis	mod	mod	high	low	low	mod	mod	n/a	mod	n/a	
St. Louis city	low	mod	high	low	high	mod	mod	n/a	mod	n/a	
Ste. Genevieve	low	low	mod	low	low	high	mod	high	high	n/a	
Stoddard	n/a	mod	high	n/a	mod	high	n/a	mod	mod	n/a	
Stone	low	low	low	low	low	high	mod	high	high	n/a	
Sullivan	low	mod	low	low	mod	low	mod	mod	mod	low	Lightning
Taney	high	mod	low	low	mod	high	high	high	low	n/a	
Texas	low	mod	low	mod	low	high	mod	high	high	n/a	
Vernon	mod	low	low	mod	mod	high	mod	high	high	n/a	
Warren	mod	low	high	high	low	high	mod	mod	mod	n/a	
Washington	low	low	mod	low	low	low	low	mod	mod	n/a	
Wayne	mod	mod	high	low	low	high	mod	n/a	mod	n/a	
Webster	low	mod	mod	low	mod	high	high	high	high	n/a	
Worth	low	mod	low	low	n/a	mod	mod	mod	mod	n/a	
Wright	low	low	low	low	low	low	mod	mod	mod	n/a	

3.3.2 Estimating Potential Losses

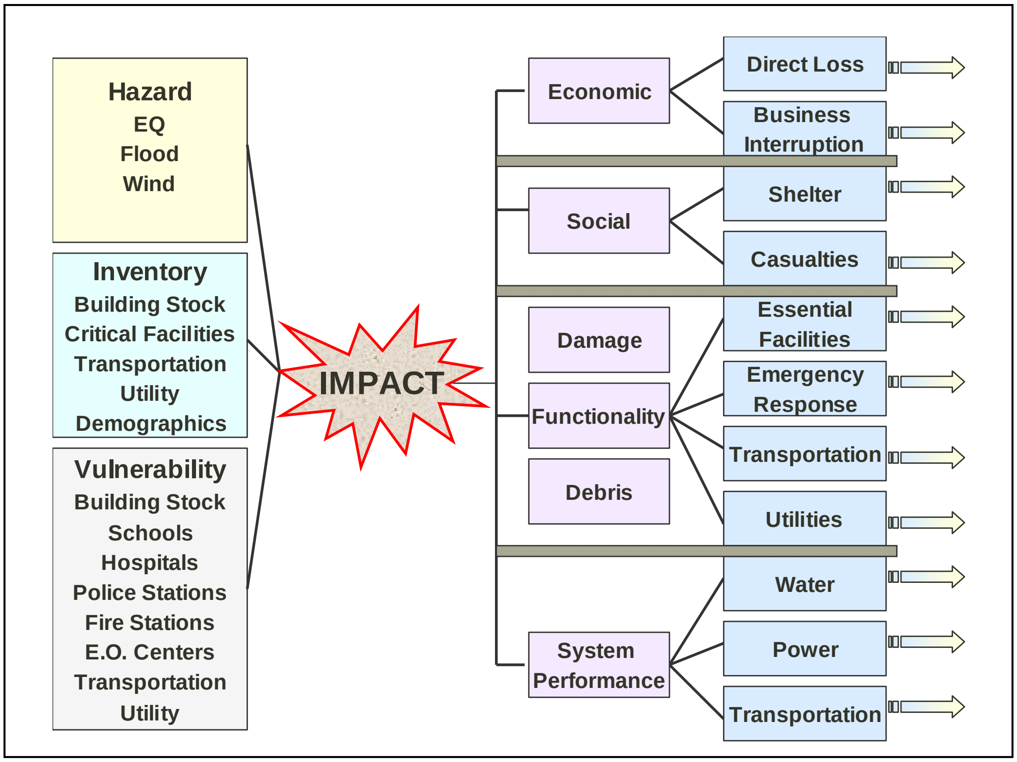
Loss estimates provided herein are based on available data, and the methodologies applied resulted in an approximation of risk. These estimates are used to understand relative risk from hazards and potential losses. Uncertainties are inherent in any loss-estimation methodology, arising in part from incomplete observed data and scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis (such as incomplete inventories, demographics, or economic parameters).

Loss estimations were conducted for the priority hazards (riverine flooding, tornadoes, and earthquakes) based on available data and methodologies. For the majority of the risk assessment, three hazard risk assessment methodologies were applied: 1) Hazards United States—Multi-Hazards (HAZUS-MH), FEMA's loss-estimation software (earthquake and flood), 2) a statistical risk assessment methodology (tornadoes) and 3) summarization of local mitigation plan loss estimates (flooding). These approaches provide estimates for potential impacts by using a common, systematic framework for evaluation. Insurance claims and repetitive losses reported by the National Flood Insurance Program were also analyzed for riverine flooding.

HAZUS-MH

HAZUS-MH is FEMA's standardized loss-estimation software program built upon an integrated geographic information system platform (see Figure 3.93). The HAZUS-MH risk assessment methodology is parametric in that distinct hazard, vulnerability, and inventory parameters (earthquake spectral ordinates, building construction, and building classes) were modeled using the HAZUS-MH software to determine the impact on the built environment (damage and losses). This risk assessment applied HAZUS-MH to produce regional profiles and estimate losses for two hazards: earthquakes and riverine flooding.

Figure 3.93. Conceptual Model of HAZUS-MH Methodology



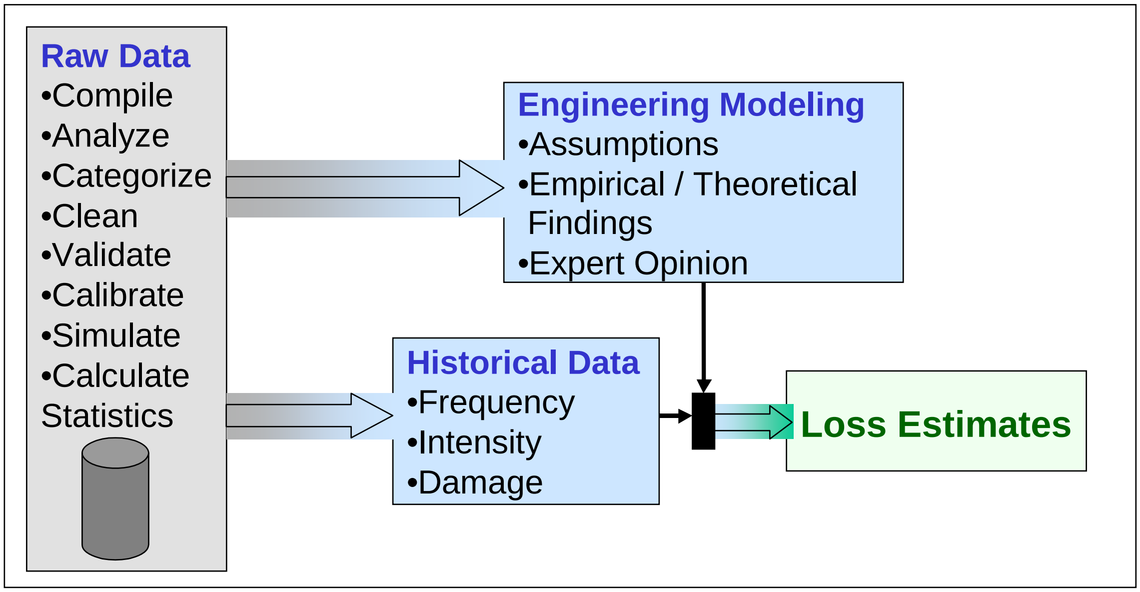
Statistical Risk Assessment Methodology

The statistical risk assessment methodology was applied to analyze hazards of concern that are outside the scope of HAZUS-MH, in this case, tornadoes. This approach is based on different principals than HAZUS-MH and does not rely on readily available automated software. It uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. Historical data for each hazard are used and statistical evaluations are performed using manual calculations. Figure 3.94 illustrates a conceptual model of the statistical risk assessment methodology as applied to tornadoes in Missouri. The general steps used in the statistical risk assessment methodology are summarized below:

- Compile data from national and local sources
- Conduct statistical analysis of data to relate historical patterns within data to existing hazard models (minimum, maximum, average, and standard deviation)
- Categorize hazard parameters for each hazard to be modeled (e.g., tornadoes)
- Develop model parameters based on analysis of data, existing hazard models, and risk engineering judgment
- Apply hazard model including:
  - Analysis of frequency of hazard occurrence
  - Analysis of intensity and damage parameters of hazard occurrence

– Development of intensity and frequency tables and curves based on observed data
– Development of simple damage function to relate hazard intensity to a level of damage (e.g., one flood = $ in estimated damage)
– Development of exceedence and frequency curves relating a level of damage for each hazard to an annual probability of occurrence
– Development of annualized loss estimates

Figure 3.94. Conceptual Model of the Statistical Risk Assessment Methodology



Local Mitigation Plan Loss Estimates

To assess potential losses, the state extracted data from local plans' vulnerability assessments for the hazards the jurisdictions had ranked either High or Moderate. A generic statement in many of the plans reads "loss estimates were calculated using a combination of information from the community profiles, historical loss data in the hazard profiles, parcel information, and general knowledge of the jurisdiction. Rough economic estimates were also included. For assessments reflecting 100 percent of the county's total resources, the planning area should be assumed to be evenly at risk to that respective hazard." Thus, for many hazards that could have an impact anywhere in the county, such as severe winter weather or tornadoes, it was difficult to refine the loss estimate further.

After extensive review of the loss-estimate data, the state determined that it was not suitable for county to county comparisons of loss, due largely to the different methods used by the counties to estimate, or interpret, potential loss. Reasons for largely excluding this data include:

- Accurate loss ratios were not possible as total exposure was rarely identified. Many plans considered total vulnerability to be the potential losses of all hazards added together, which would mean losing property many times over.

- Hazard scenarios were not consistent and therefore not comparable against each other (e.g., one county may have considered vulnerability to an F2 tornado that has an impact on 10 percent of the jurisdiction, where another county considered an F4 tornado with an impact on 40 percent of the jurisdiction).
- There was no consistently applied definition of “undeveloped.” Some counties considered it unincorporated land, others considered it potential future development, some considered it rural, and others did not specify. This added to the complexity of the data capture process.

The exception to the above issues was flood, where many of the plans were able to summarize the population and buildings at risk within the 100-year floodplain. Section 3.3.3 Riverine Flooding, examines potential losses to this hazard.

Economic Impact

Risk assessment is presented for annualized losses, whenever possible. In general, presenting results in the annualized form is very useful for three reasons:

- Contribution of potential losses from all (long term) future disasters is accounted for with this approach.
- Results in this form for different hazards are readily comparable and hence easier to rank.
- When evaluating mitigation alternatives, use of annualized losses is an objective approach.

The economic loss results are presented here using two interrelated risk indicators:

- The annualized expected loss (AEL), which is the estimated expected long-term value of losses to the general building stock for a specified geographic area (i.e., county)
- The annualized loss ratio (ALR), which expresses estimated annualized loss as a fraction of the building inventory replacement value

The estimated AEL addresses key components of risk: the probability of a hazard event occurring in the study area, the consequences of the event (largely a function of building construction type and quality), and the intensity of the event. By annualizing estimated losses, the AEL factors in historic patterns of frequent small events with infrequent larger events to provide a balanced presentation of the risk. In HAZUS-MH, losses are annualized for earthquake return periods of 100, 250, 500, 750, 1,000, 1,500, 2000, and 2,500 years.

The ALR represents the AEL as a fraction of the replacement value of the local building inventory. It gauges the relationship between average annualized loss and building replacement value. This ratio can be used as a measure of relative risk between areas and, since it is normalized by replacement value, it can be directly compared across different geographic units such as metropolitan areas or counties. It can also be used as a measure of community sustainability following a disaster.

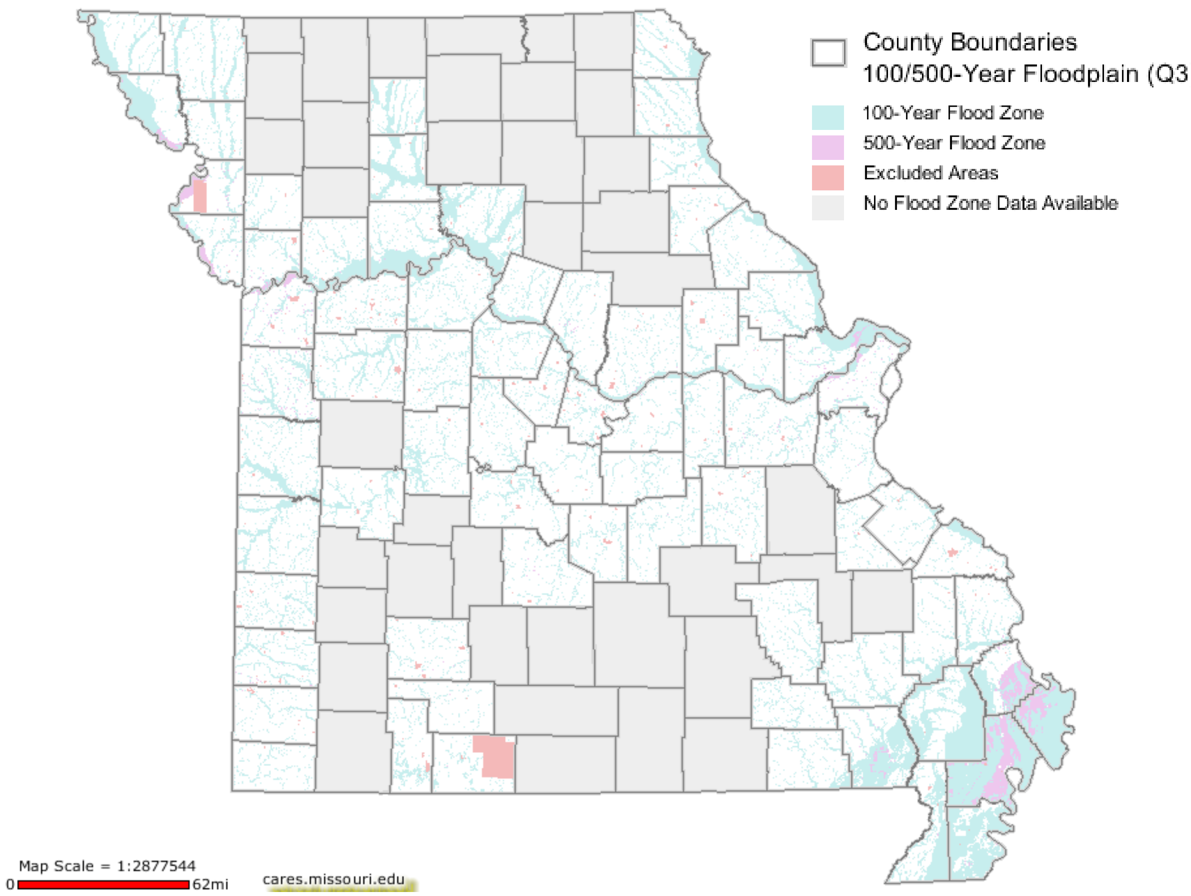
Annualized losses for the hazards where the parametric approach is used are computed automatically using a probabilistic approach. For tornadoes, where the statistical approach was used, the computations are based primarily on the observed historical losses. Using the previously described methodology, results were obtained for the top-priority hazards. The results are discussed in order of priority hazard: riverine flooding, tornadoes, and earthquakes.

3.3.3 Riverine Flooding

Note: For background information about riverine flooding, see the profile in Section 3.2.7.

As indicated in the state and local hazard identification process, floods are a concern statewide. Figure 3.95 illustrates the riverine flooding potential for all counties in Missouri.

Figure 3.95. Riverine Flooding Potential



Source: University of Missouri Center for Agricultural, Resource, and Environmental Systems

During the 2007 plan update, the state used the most recent release of HAZUS-MH MR2 (May 2006) to model flood loss for every Missouri county and St. Louis City. HAZUS-MH can assess flood loss for an entire county if digital terrain data exists. Since digital elevation models (DEMs) were available for the entire state, the state was able to use HAZUS-MH to develop

computer generated floodplain boundaries for the flood elevation that has a 1-percent chance of being equaled or exceeded each year (hereafter referred to as the "base flood," also known as the 100-year flood) on major streams in each county (see Figure 3.96). HAZUS-MH computes the potential flood impact on a building inventory database based on the extent and depth of the modeled floodwaters, enabling a consistent methodology for a county-by-county assessment of potential flood losses.

Figure 3.96. HAZUS-MH Countywide Base-Flood Scenarios: Modeled Floodplain Boundaries

The HAZUS-MH flood analysis was a significant undertaking for the state. Producing a HAZUS-MH flood run is very computer resource intensive. Processing a single county takes an average of 12 hours from start to finish, depending on the size of the county, density of the stream network, and density of census blocks. A single machine dedicated to running HAZUS-

MH was used continually over a period of three months. Three additional computers ran HAZUS-MH overnight in order to produce the needed results.

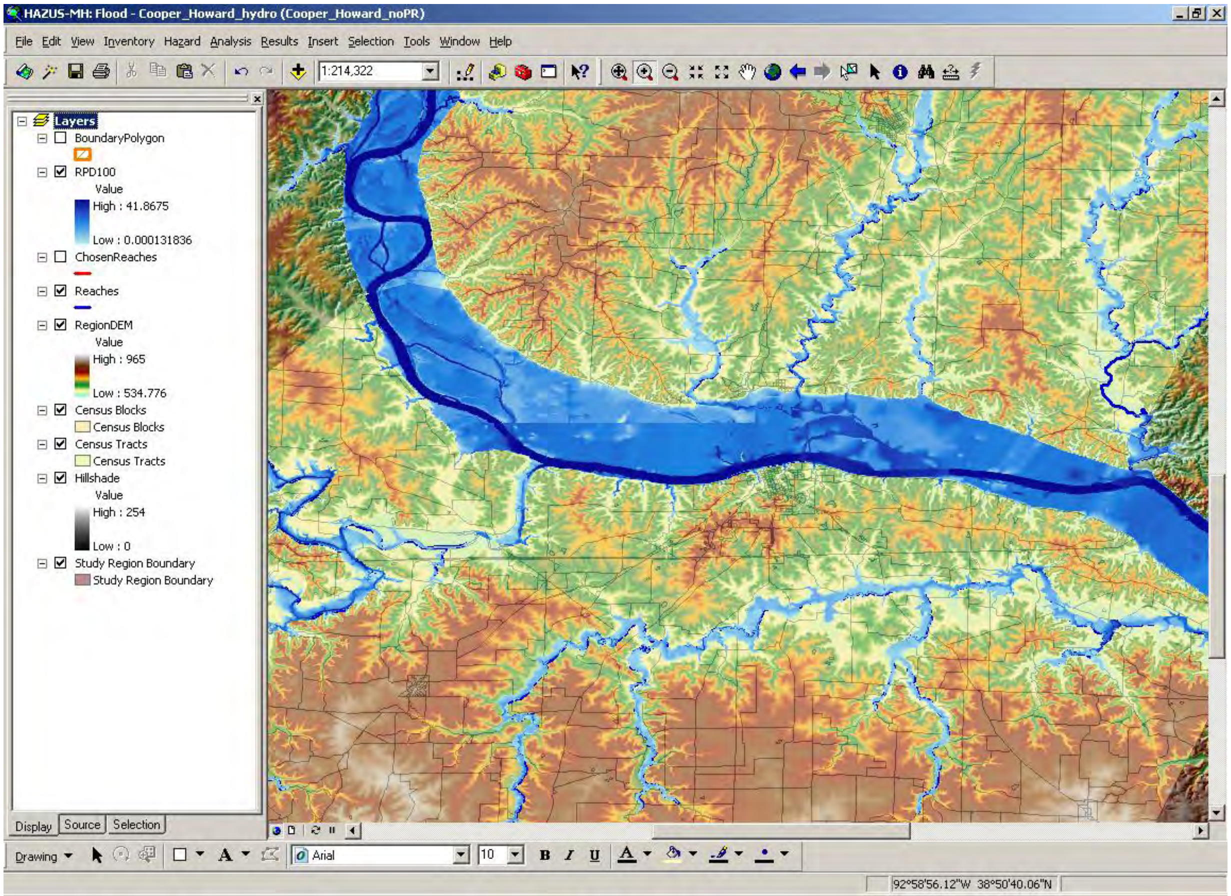
To develop countywide probabilistic analyses for each county, the following parameters were used:

- Thirty-meter resolution DEMs as the terrain base to develop hydrologic and hydraulic models
- Streams and rivers with a minimum drainage basin area of 10 square miles all experiencing a base flood at the same time
- U.S. Geological Survey hydrologic regional regression equations and stream gage data included in HAZUS-MH
- HAZUS-MH building inventory defaults summarized to the census-block level with 2005 building valuations

Note: In some cases, 10-meter resolution DEMs were used as a substitute for problem areas in the corresponding 30-meter DEMs. A sensitivity analysis comparing 10-meter DEMs with 30-meter DEMs was run for some counties. While the 10-meter DEM produces slightly more accurate floodplain boundaries, the slight difference in the impact results did not justify the additional processing time it would have taken to run 10-meter DEMs for all counties.

HAZUS-MH produces a flood polygon and flood depth grid that represents the base flood. While not as accurate as official flood maps, such as digital flood insurance rate maps, these floodplain boundaries are available for use in GIS and could be valuable to communities that have not been mapped by the National Flood Insurance Program. Also, a statewide digital flood hazard layer was created by appending floodplain boundaries created in each county run (refer back to Figure 3.96). Figures 3.97 and 3.98 show sample HAZUS-MH flood hazard outputs.

Figure 3.97. Example of a Floodplain Depth Grid Output by HAZUS-MH on the Missouri River—Cooper and Howard Counties



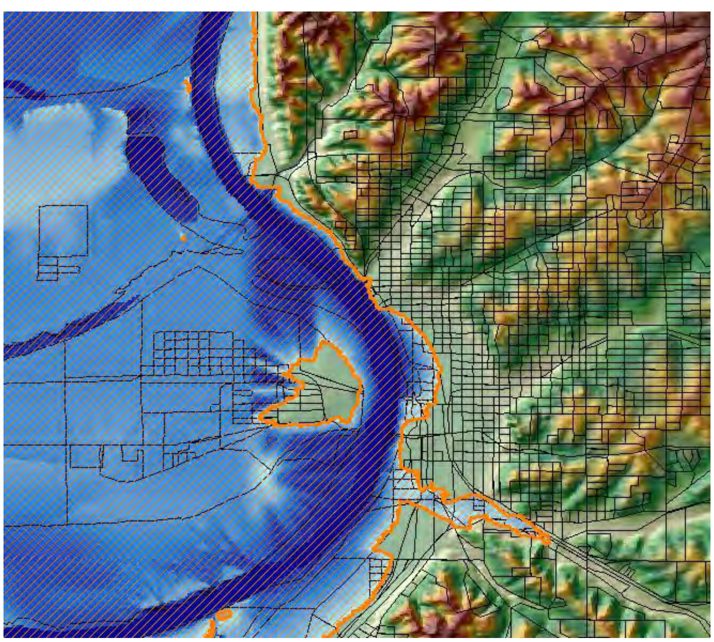


Figure 3.98. Example of HAZUS-MH Floodplain Boundary and Depth Detail and Census Blocks—St. Joseph

Black lines make up polygons that indicate census blocks. The smaller the census blocks and the more densely clustered the block polygons, the more likely the area is to be densely developed and populated. The orange line represents the modeled base flood hazard boundary. The blue color indicates flood depth, with deeper blue representing deeper water.

Flood Damage Estimates, Societal Impacts, and Agriculture Impacts

The intent of this analysis was to enable the state to estimate where flood losses could occur and the degree of severity using a consistent methodology. The computer modeling helps quantify risk along known flood-hazard corridors such as along the Mississippi and Missouri rivers. In addition, flood losses are estimated for certain lesser streams and rivers where the flood hazard may not have been previously studied.

HAZUS-MH impact analyses were run for direct economic losses for buildings and societal impacts (displaced people and shelter needs) to see which counties ranked the highest on these risk indicators (see the tables and figures that follow and Appendix C HAZUS-MH Flood Results by County). Using GIS, HAZUS-MH flood results were mapped to show flood loss potential and how it varies across the state. The primary indicators used to assess flood losses were:

- Direct building losses combined with income losses (see Table 3.72 and Figure 3.99),
- Direct building losses (see Table 3.73 and Figure 3.100),
- Loss ratio of the direct building losses compared to overall building inventory (see Table 3.74 and Figure 3.101)[2], and
- Population displaced by the flood and shelter needs (see Table 3.75 and Figure 3.102).

[2] The loss ratio of the direct building losses compared to overall building inventory per county gives an indication of the severity of impacts on community sustainability. While a large urban area may have the greatest dollar losses, it may be able to absorb the impact better than a more rural area where a flood could impact a significant amount of the infrastructure in the entire county.

Table 3.72. Top 25 Counties Based on Total Direct Building Loss and Income Loss

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income loss	Total Direct and Income Loss	Loss Ratio	# Bldgs Risk	# Bldgs Substantially Damaged
St. Louis	$606,219,000	$919,268,000	$66,943,000	$1,592,430,000	$849,988,000	$2,442,418,000	0.81%	1,852	47
Jackson	$416,396,000	$639,720,000	$41,524,000	$1,097,640,000	$708,470,000	$1,806,110,000	0.92%	1,397	99
Clay	$399,290,000	$593,948,000	$38,013,000	$1,031,251,000	$541,997,000	$1,573,248,000	3.13%	1,208	367
Pemiscot	$149,637,000	$175,951,000	$3,451,000	$329,039,000	$327,493,000	$656,532,000	18.53%	2,028	1029
Cole	$35,015,000	$36,467,000	$520,000	$72,002,000	$483,689,000	$555,691,000	0.81%	230	4
St. Charles	$107,966,000	$104,099,000	$3,833,000	$215,898,000	$87,979,000	$303,877,000	0.61%	918	112
Platte	$68,425,000	$97,825,000	$6,833,000	$173,083,000	$59,711,000	$232,794,000	1.39%	214	9
Jefferson	$95,162,000	$69,632,000	$1,522,000	$166,316,000	$38,434,000	$204,750,000	0.89%	858	13
Boone	$41,861,000	$58,824,000	$808,000	$101,493,000	$81,800,000	$183,293,000	0.53%	181	1
St. Louis City	$45,481,000	$54,041,000	$2,268,000	$101,790,000	$71,506,000	$173,296,000	0.20%	388	10
Franklin	$53,617,000	$43,905,000	$1,920,000	$99,442,000	$26,469,000	$125,911,000	1.03%	332	1
Butler	$20,578,000	$35,244,000	$1,674,000	$57,496,000	$56,500,000	$113,996,000	1.09%	285	116
Crawford	$17,683,000	$23,184,000	$736,000	$41,603,000	$58,339,000	$99,942,000	1.58%	66	0
Buchanan	$25,459,000	$32,773,000	$1,716,000	$59,948,000	$34,625,000	$94,573,000	0.49%	213	12
Cape Girardeau	$16,259,000	$24,488,000	$954,000	$41,701,000	$32,283,000	$73,984,000	0.40%	71	0
Wayne	$13,782,000	$23,721,000	$1,496,000	$38,999,000	$31,416,000	$70,415,000	2.24%	80	3
McDonald	$20,105,000	$23,819,000	$1,273,000	$45,197,000	$24,383,000	$69,580,000	2.76%	197	2
Holt	$11,916,000	$9,032,000	$114,000	$21,062,000	$36,057,000	$57,119,000	4.34%	200	59
Lincoln	$27,744,000	$17,778,000	$288,000	$45,810,000	$7,479,000	$53,289,000	1.55%	276	36
Jasper	$19,169,000	$19,942,000	$802,000	$39,913,000	$12,884,000	$52,797,000	0.36%	194	1
Ripley	$13,938,000	$20,662,000	$3,564,000	$38,164,000	$9,279,000	$47,443,000	2.75%	70	2
Taney	$14,663,000	$14,815,000	$316,000	$29,794,000	$17,326,000	$47,120,000	0.67%	119	6
Marion	$12,680,000	$17,231,000	$1,019,000	$30,930,000	$14,820,000	$45,750,000	0.81%	86	4
Stone	$20,766,000	$13,482,000	$123,000	$34,371,000	$11,169,000	$45,540,000	1.40%	183	0
New Madrid	$13,771,000	$12,859,000	$176,000	$26,806,000	$17,875,000	$44,681,000	1.62%	295	191

Source: HAZUS-MH MR2

Figure 3.99. HAZUS-MH Countywide Base-Flood Scenarios: Building and Income Loss

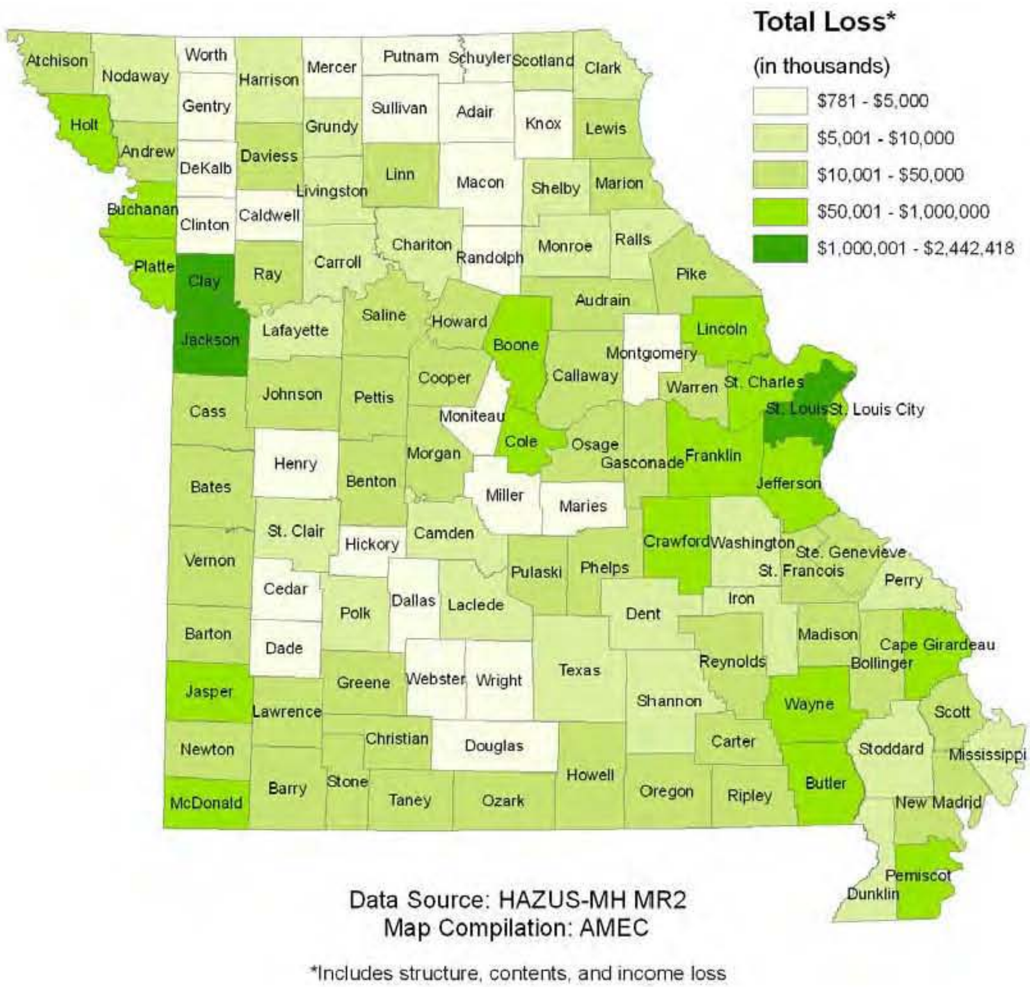


Table 3.73. Top 25 Counties Based on Total Direct Building Loss

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss
St. Louis	$606,219,000	$919,268,000	$66,943,000	$1,592,430,000
Jackson	$416,396,000	$639,720,000	$41,524,000	$1,097,640,000
Clay	$399,290,000	$593,948,000	$38,013,000	$1,031,251,000
Pemiscot	$149,637,000	$175,951,000	$3,451,000	$329,039,000
St. Charles	$107,966,000	$104,099,000	$3,833,000	$215,898,000
Platte	$68,425,000	$97,825,000	$6,833,000	$173,083,000
Jefferson	$95,162,000	$69,632,000	$1,522,000	$166,316,000
St. Louis City	$45,481,000	$54,041,000	$2,268,000	$101,790,000
Boone	$41,861,000	$58,824,000	$808,000	$101,493,000
Franklin	$53,617,000	$43,905,000	$1,920,000	$99,442,000
Cole	$35,015,000	$36,467,000	$520,000	$72,002,000
Buchanan	$25,459,000	$32,773,000	$1,716,000	$59,948,000
Butler	$20,578,000	$35,244,000	$1,674,000	$57,496,000
Lincoln	$27,744,000	$17,778,000	$288,000	$45,810,000
McDonald	$20,105,000	$23,819,000	$1,273,000	$45,197,000
Cape Girardeau	$16,259,000	$24,488,000	$954,000	$41,701,000
Crawford	$17,683,000	$23,184,000	$736,000	$41,603,000
Jasper	$19,169,000	$19,942,000	$802,000	$39,913,000
Wayne	$13,782,000	$23,721,000	$1,496,000	$38,999,000
Ripley	$13,938,000	$20,662,000	$3,564,000	$38,164,000
Stone	$20,766,000	$13,482,000	$123,000	$34,371,000
Greene	$15,691,000	$16,568,000	$210,000	$32,469,000
Marion	$12,680,000	$17,231,000	$1,019,000	$30,930,000
Taney	$14,663,000	$14,815,000	$316,000	$29,794,000
St. Francois	$15,513,000	$12,392,000	$124,000	$28,029,000

Source: HAZUS-MH MR2

Figure 3.100. HAZUS-MH Countywide Base-Flood Scenarios: Building Loss

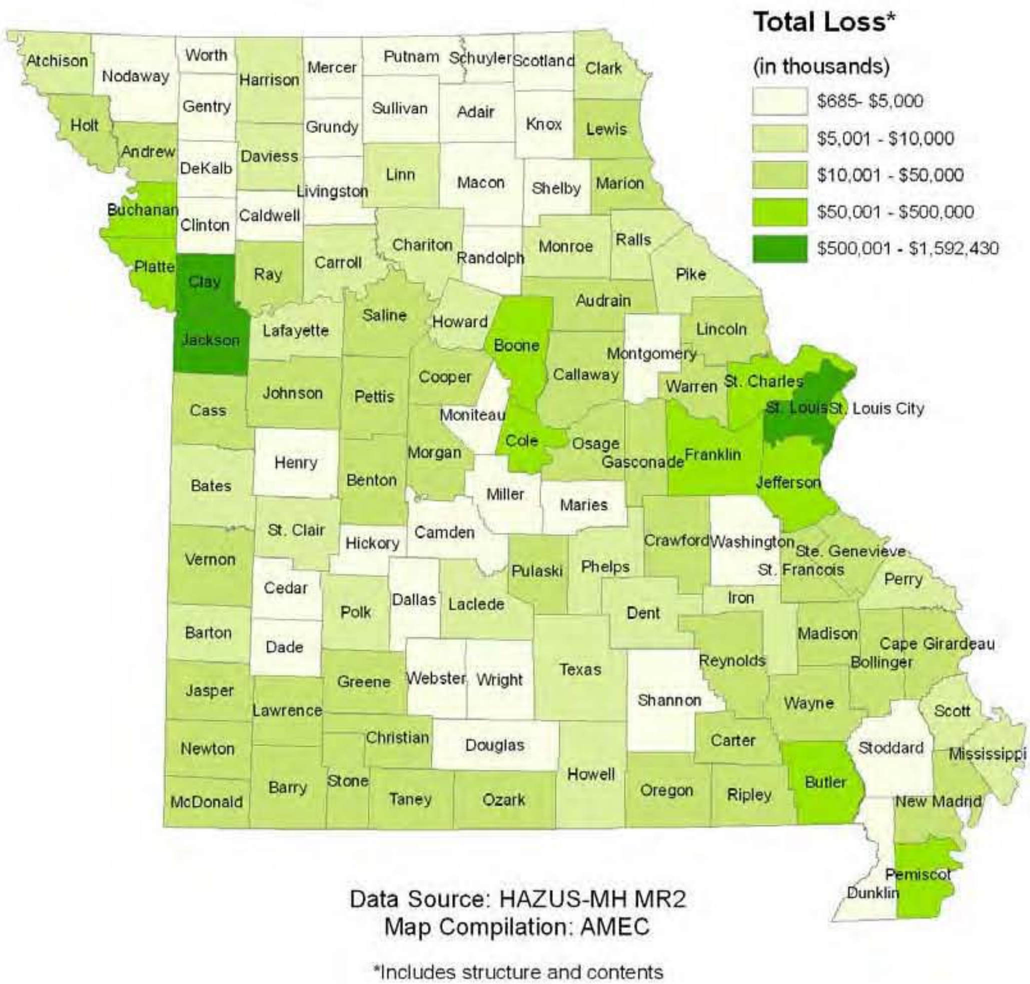
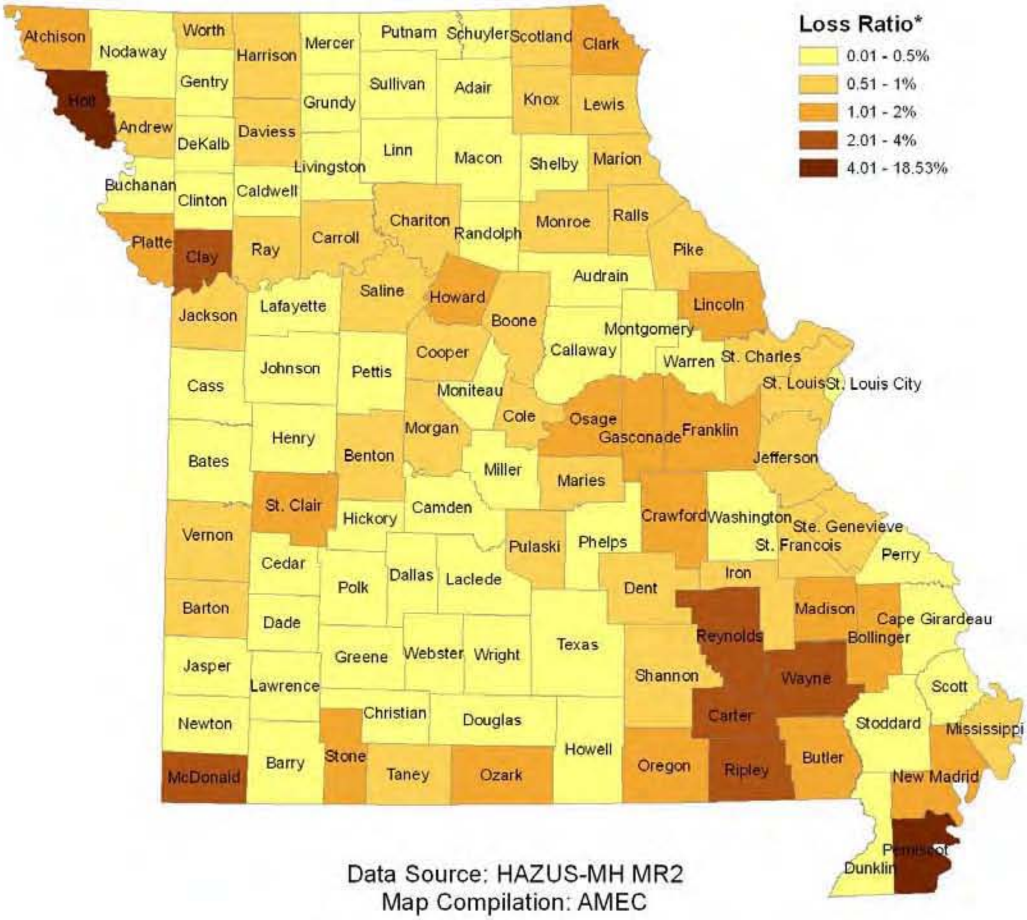


Table 3.74. Top 25 Counties Based on Building Loss Ratio

County	Structural Damage	Countywide Building Exposure	Loss Ratio
Pemiscot	$149,637,000	$807,586,000	18.53%
Holt	$11,916,000	$274,294,000	4.34%
Carter	$8,528,000	$269,873,000	3.16%
Clay	$399,290,000	$12,766,168,000	3.13%
McDonald	$20,105,000	$729,267,000	2.76%
Ripley	$13,938,000	$506,849,000	2.75%
Reynolds	$8,330,000	$341,902,000	2.44%
Wayne	$13,782,000	$616,116,000	2.24%
Oregon	$7,059,000	$394,601,000	1.79%
New Madrid	$13,771,000	$850,397,000	1.62%
Osage	$12,676,000	$785,519,000	1.61%
Crawford	$17,683,000	$1,116,986,000	1.58%
Lincoln	$27,744,000	$1,785,378,000	1.55%
Madison	$7,962,000	$552,613,000	1.44%
Ozark	$5,632,000	$399,368,000	1.41%
Stone	$20,766,000	$1,480,692,000	1.40%
Platte	$68,425,000	$4,908,320,000	1.39%
Atchison	$4,110,000	$325,720,000	1.26%
Gasconade	$10,175,000	$838,880,000	1.21%
Howard	$4,994,000	$439,617,000	1.14%
Clark	$3,740,000	$332,397,000	1.13%
Bollinger	$5,590,000	$497,879,000	1.12%
St. Clair	$4,810,000	$435,085,000	1.11%
Butler	$20,578,000	$1,883,957,000	1.09%
Franklin	$53,617,000	$5,194,361,000	1.03%

Source: HAZUS-MH MR2

Figure 3.101. HAZUS-MH Countywide Base-Flood Scenarios: Building Loss Ratio



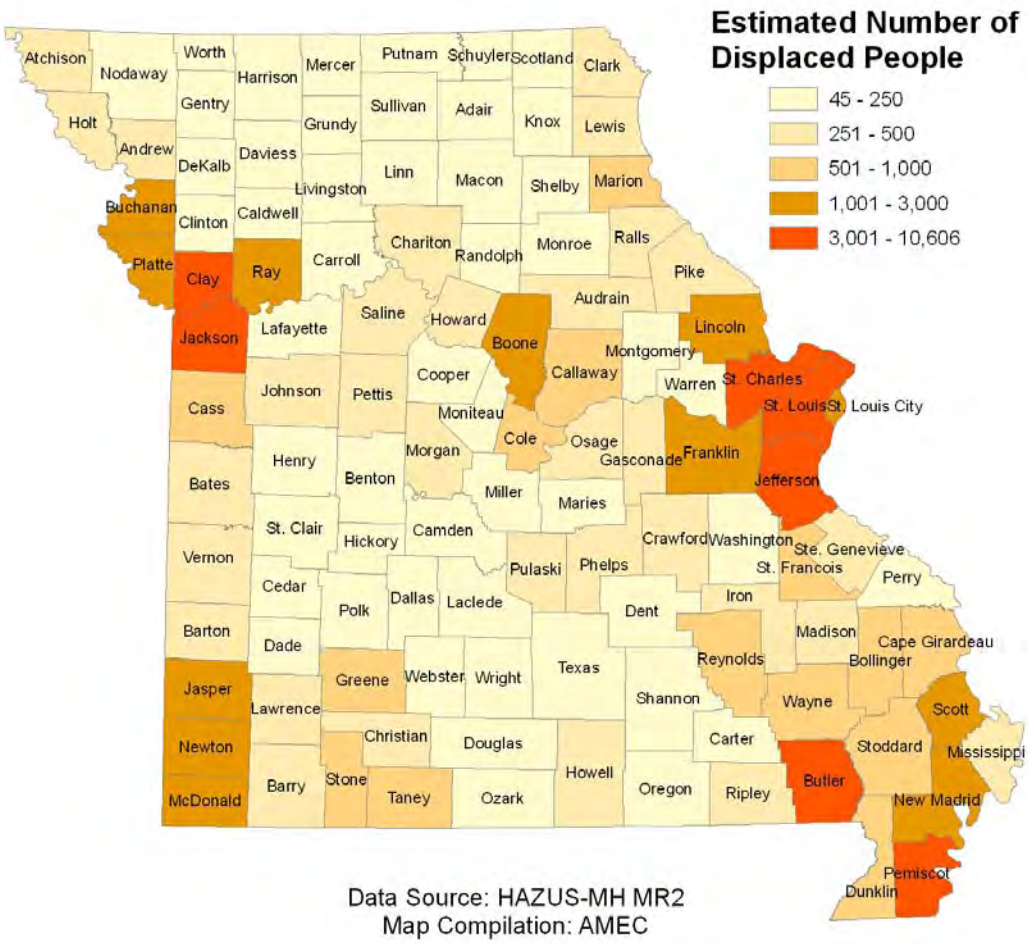
*Loss Ratio is the ratio of the value of damaged structures to the total inventory value within the county

Table 3.75. Top 25 Counties Based on Displaced People

County	Displaced People	People Needing Shelter
Pemiscot	10,606	8,769
St. Louis	9,960	8,490
Jackson	6,444	5,005
Clay	6,073	5,062
Jefferson	4,827	3,203
Butler	3,607	2,449
St. Charles	3,443	1,827
New Madrid	2,895	1,656
St. Louis City	2,825	2,520
Jasper	1,792	841
Franklin	1,633	557
Lincoln	1,454	478
Boone	1,379	752
Buchanan	1,339	661
Ray	1,302	647
McDonald	1,258	519
Scott	1,240	627
Newton	1,107	481
Platte	1,087	469
Greene	897	340
Wayne	893	363
Cape Girardeau	827	332
Dunklin	773	292
Taney	770	368
Cole	727	253

Source: HAZUS-MH MR2

Figure 3.102. HAZUS-MH Countywide Base-Flood Scenarios: Displaced People



The HAZUS-MH methodology provides the number of buildings impacted, estimates of the building repair costs, and the associated loss of building contents and business inventory. Building damage can also cause additional losses to a community as a whole by restricting a building's ability to function properly. Income loss data accounts for losses such as business interruption and rental income losses as well as the resources associated with damage repair and job and housing losses. These losses are calculated by HAZUS-MH using a methodology based on the building damage estimates.

Flood damage is directly related to the depth of flooding. For example, a two-foot-deep flood generally results in about 20 percent damage to the structure (which translates to 20 percent of the structure's replacement value). HAZUS-MH takes into account flood depth when modeling damage (based on FEMA's depth-damage functions). The HAZUS-MH reports capture damage by occupancy class (in terms of square footage impacted) by damage percent classes. Occupancy classes in HAZUS-MH include agriculture, commercial, education, government, industrial, religion, and residential. Damage percent classes are grouped by 10 percent increments: 1-10

percent, 11-20 percent, etc., up to 50 percent. Buildings that sustain more than 50 percent damage are considered to be "substantially" damaged.

Data Limitation Note: The damaged building counts generated by HAZUS-MH are susceptible to rounding errors and are likely the weakest output of the model due to the use of census blocks for analysis. HAZUS-MH reports include this disclaimer: "Unlike the earthquake and hurricane models, the flood model performs its analysis at the census block level. This means that the analysis starts with a small number of buildings within each census block and applies a series of distributions necessary for analyzing the potential damage. The application of these distributions and the small number of buildings make the flood model more sensitive to rounding errors that introduces uncertainty into the building count results. Please use these results with suitable caution." The counts of buildings at risk collected from the local hazard mitigation plans could potentially provide a more realistic estimate of the actual numbers of buildings in the base-flood hazard areas (see the Local Plan Flood Risk Assessments section that follows).

The displaced population is based on the inundation area. Individuals and households will be displaced from their homes even when the home has suffered little or no damage either because they were evacuated (i.e., a warning was issued) or there was no physical access to the property because of flooded roadways. Displaced people using shelters will most likely be individuals with lower incomes and those who do not have family or friends within the immediate area. Age plays a secondary role in shelter use in that there are some individuals who will go to a public shelter even if they have the financial means to go elsewhere. These will usually be younger, less established families and elderly families (HAZUS-MH Users Manual). HAZUS-MH does not model flood casualties given that flood-related deaths and injuries typically do not have the same significant impact on the medical infrastructure as those associated with earthquakes.

HAZUS-MH also has the ability to model flood losses to agriculture, in particular crop losses. It uses the National Resources Inventory (NRI) data as the default agriculture inventory. The NRI provides crop type and units data captured approximately every five years. The southeast Missouri Bootheel region is where the state's prime agricultural lands are located, in the lowlands of the Mississippi River floodplain. The following counties were analyzed for crop losses from flooding, identified by the Missouri Department of Agriculture: Butler, Cape Girardeau, Stoddard, Scott, New Madrid, Mississippi, Dunklin, and Pemiscot. A hypothetical flood date of September 1 was used as the target date because it has the potential to harm not only the crop in the field but also the next growing season. Table 3.76 summarizes potential impacts to agriculture from this hypothetical flood in the Bootheel region. A flood in late May or early June could also prove devastating, since crops would have been recently planted. One limitation to the data used in this analysis is the absence of cotton in the HAZUS-MH default agriculture data. Cotton is a major commodity in the Bootheel region.

Table 3.76. Summary of Potential Flood Impacts to Agriculture in the Bootheel Region

	Crop Loss		
	Day 3	Day 7	Day 14
Bollinger			
Corn	$6,772,553.47	$6,772,553.47	$6,772,553.47
Soybeans	$4,574,684.23	$6,099,578.97	$6,099,578.97
Wheat	$1,082,972.57	$1,082,972.57	$1,082,972.57
Study Case Total	$12,430,210.27	$13,955,105.01	$13,955,105.01
Butler			
Corn	$8,984,338.67	$8,984,338.67	$8,984,338.67
Soybeans	$7,791,470.34	$10,388,627.12	$10,388,627.12
Wheat	$5,264,353.37	$5,264,353.37	$5,264,353.37
Study Case Total	$22,040,162.38	$24,637,319.16	$24,637,319.16
Cape Girardeau			
Corn	$7,010,545.32	$7,010,545.32	$7,010,545.32
Soybeans	$5,114,114.57	$6,818,819.42	$6,818,819.42
Wheat	$2,491,688.32	$2,491,688.32	$2,491,688.32
Study Case Total	$14,616,348.21	$16,321,053.06	$16,321,053.06
Dunklin			
Corn	$10,192,627.15	$10,192,627.15	$10,192,627.15
Soybeans	$6,710,493.84	$8,947,325.12	$8,947,325.12
Wheat	$7,345,347.02	$7,345,347.02	$7,345,347.02
Study Case Total	$24,248,468.02	$26,485,299.30	$26,485,299.30
Mississippi			
Corn	$14,306,551.02	$14,306,551.02	$14,306,551.02
Soybeans	$17,816,387.18	$23,755,182.91	$23,755,182.91
Wheat	$11,829,431.41	$11,829,431.41	$11,829,431.41
Study Case Total	$43,952,369.61	$49,891,165.34	$49,891,165.34
New Madrid			
Corn	$23,305,348.34	$23,305,348.34	$23,305,348.34
Soybeans	$19,801,641.04	$26,402,188.06	$26,402,188.06
Wheat	$17,399,007.96	$17,399,007.96	$17,399,007.96
Study Case Total	$60,505,997.34	$67,106,544.36	$67,106,544.36
Scott			
Corn	$6,076,624.44	$8,102,165.92	$8,102,165.92
Soybeans	$4,779,308.31	$6,372,411.08	$6,372,411.08
Wheat	$4,876,180.16	$6,501,573.55	$6,501,573.55
Study Case Total	$15,732,112.92	$20,976,150.55	$20,976,150.55
Stoddard			
Corn	$16,015,413.20	$16,015,413.20	$16,015,413.20
Soybeans	$11,309,445.40	$15,079,260.53	$15,079,260.53
Wheat	$10,876,000.87	$10,876,000.87	$10,876,000.87
Study Case Total	$38,200,859.47	$41,970,674.60	$41,970,674.60

Source: HAZUS-MH MR2

HAZUS-MH can analyze additional impacts, including what type of infrastructure could be impacted, and how bad those impacts could be. Project files for each county are available for use by local governments from SEMA if more details on the impacts discussed here, or information about other impacts, such as vehicle losses, agricultural losses, utility system losses, essential facility impacts, and transportation impacts, are desired.

Data Limitation Note: Levees may not be detected on the computer terrain models. Thus, some communities that may be protected from 100-year floods from levees may be modeled by HAZUS-MH as inundated and the risk may be overestimated. Pemiscot County is one example where levee protection is not recognized by HAZUS-MH. These results, for those counties with levee protection, should be considered as the "worst-case scenario" and may represent losses that could result from a levee breach.

Local Plan Flood Risk Assessments

As mentioned previously, the state was able to use information from local plans to summarize the population and buildings at risk within the 100-year floodplain by county. Figures 3.103, 3.104, and 3.105 illustrate the local plan flood risk summary: persons impacted, buildings impacted, and potential loss.

Figure 3.103. Local Plan Flood Risk Summary: Persons Impacted

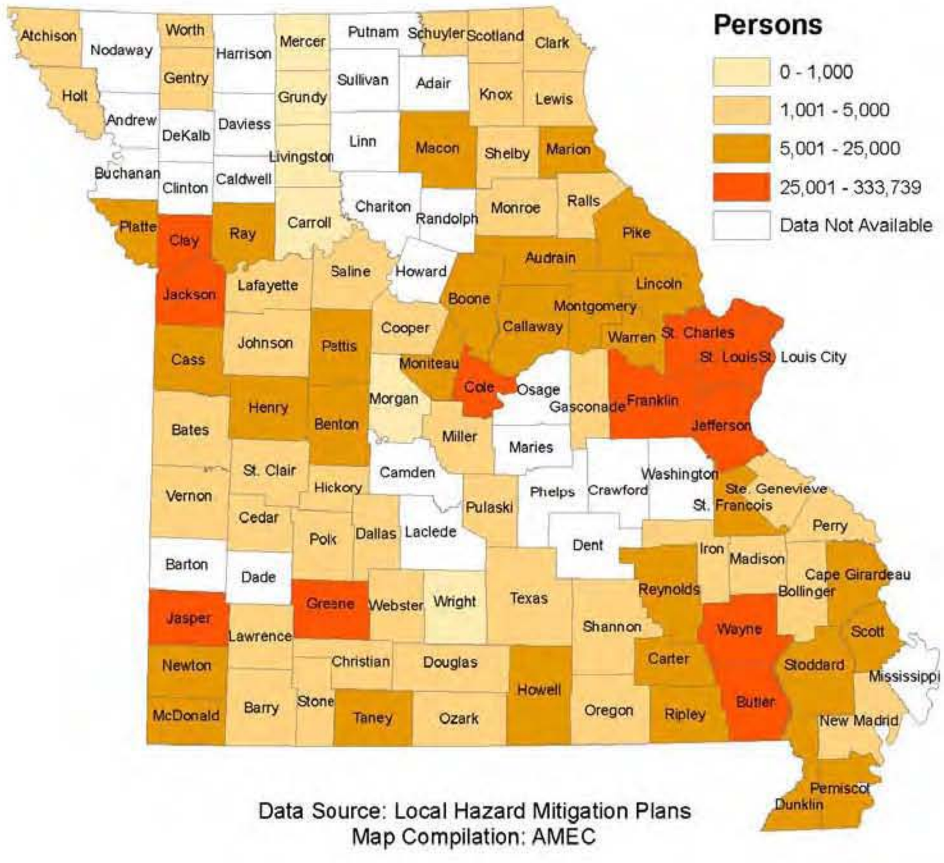


Figure 3.104. Local Plan Flood Risk Summary: Buildings Impacted

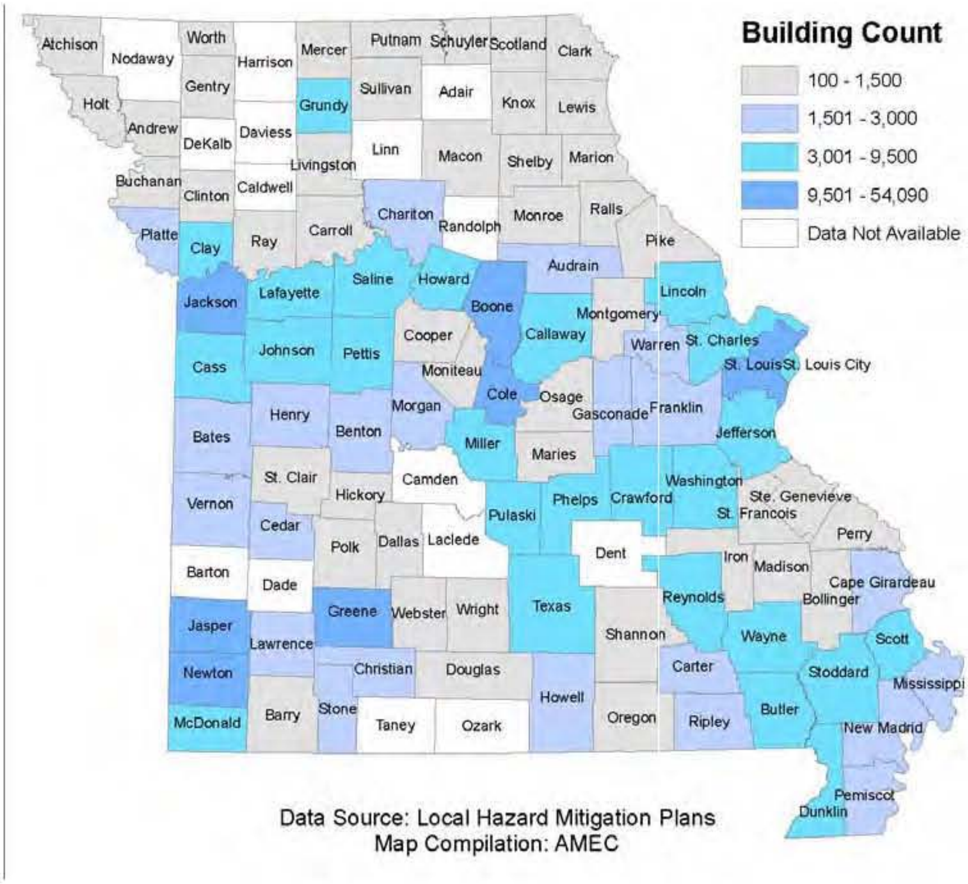
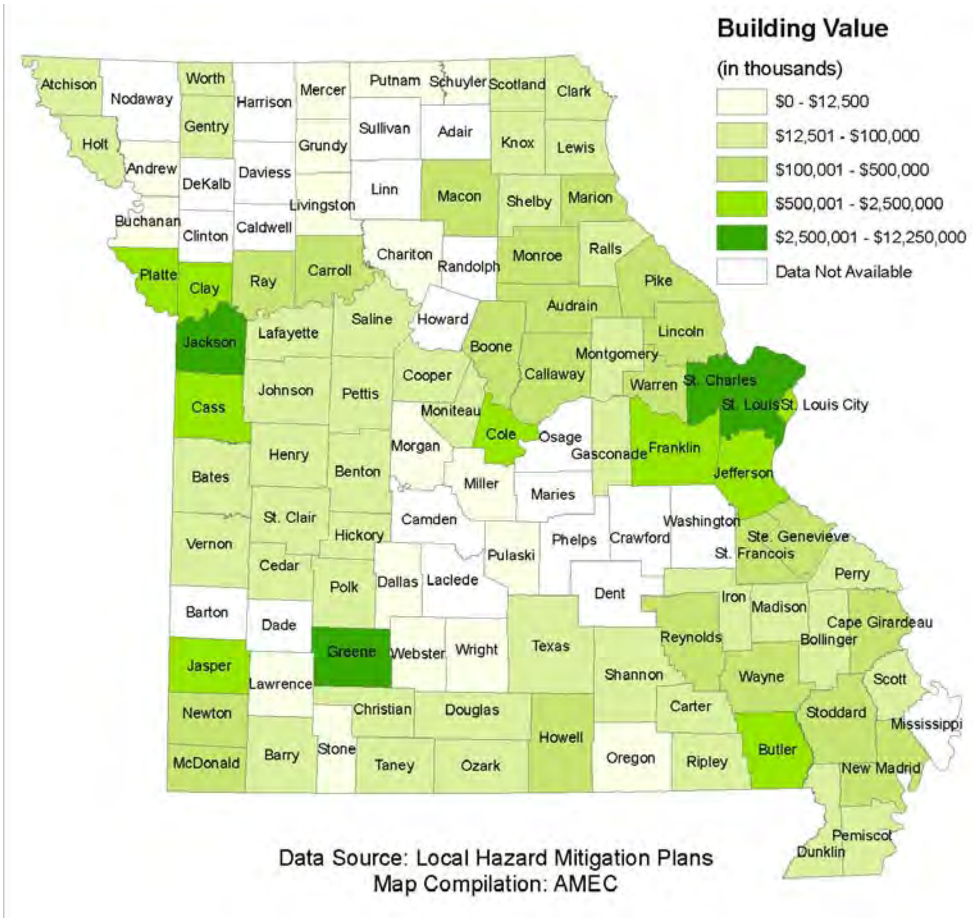


Figure 3.105. Local Plan Flood Risk Summary: Potential Loss



Flood Insurance Claims Analysis

In addition to the HAZUS-MH flood runs and local plans, the state analyzed National Flood Insurance Program (NFIP) flood-loss data to determine areas of Missouri with the greatest flood risk. Missouri flood-loss information was culled from FEMA’s “Policy and Loss Data by Community with County and State Data,” which documents losses from 1978 to the present (this analysis is based on the report dated November 26, 2006).

There are several limitations to this data, including:

- Only losses to participating NFIP communities are represented,
- Communities joined the NFIP at various times since 1978,
- The number of flood insurance policies in effect may not include all structures at risk to flooding, and
- Some of the historic loss areas have been mitigated with property buyouts.

Despite these limitations, the data depict a pattern of historic flood losses in the state. The greatest losses have been in the counties along the Mississippi River corridor, particularly St.

Charles, St. Louis, Jefferson, Lincoln, and St. Genevieve counties. Counties along the Missouri River corridor also have considerable claims and losses, particularly Clay County. Table 3.77 lists the details of the 10 Missouri counties with the greatest historic dollar losses. Figures 3.106 and 3.107 show the geographic distribution of flood payouts and claims by county across the entire state.

Note that while St. Louis County has the most historical dollars paid, St. Charles County has had more flood claims and has less than half as many policies.

Table 3.77. Top 10 Counties for Flood Insurance Dollars Paid (Historical), 1978-2006

County	Dollars Paid (Historical)	Flood Claims	Current Policies	Coverage in Thousands
St. Louis	$108,112,156	8,531	4,816	$897,059
St. Charles	$104,373,655	9,722	1,638	$240,294
Clay	$38,287,998	2,131	1,397	$315,526
Jefferson	$36,642,676	3,708	1,335	$168,863
Lincoln	$19,683,995	1,700	421	$30,126
Platte	$11,074,173	317	219	$49,820
Marion	$8,580,098	444	169	$19,824
Cape Girardeau	$7,817,511	973	298	$46,897
Franklin	$7,569,981	536	454	$54,653
St. Louis City	$6,775,730	580	413	$74,617

Source: FEMA, “Policy and Loss Data by Community with County and State Data,” November 26, 2006

Figure 3.106. Map of Dollars Paid Historically for Flood Insurance Losses in Missouri by County, 1978-2006

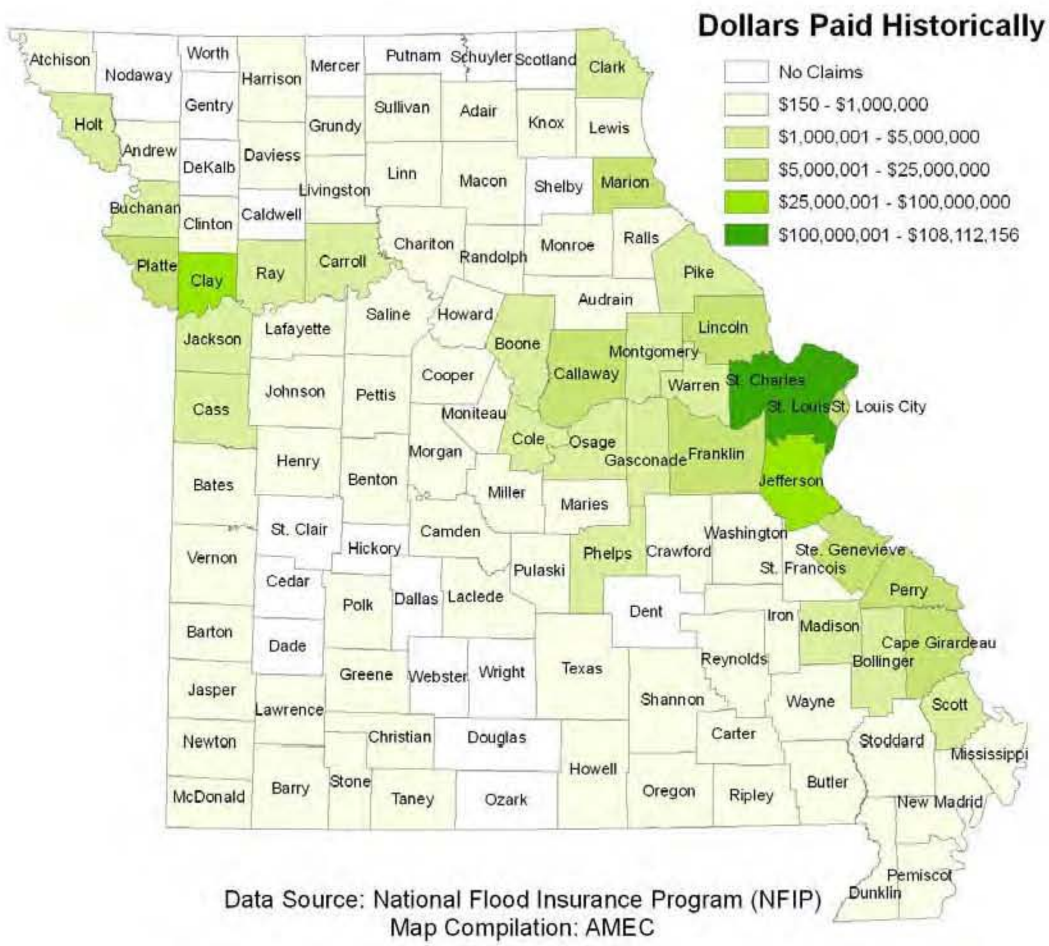
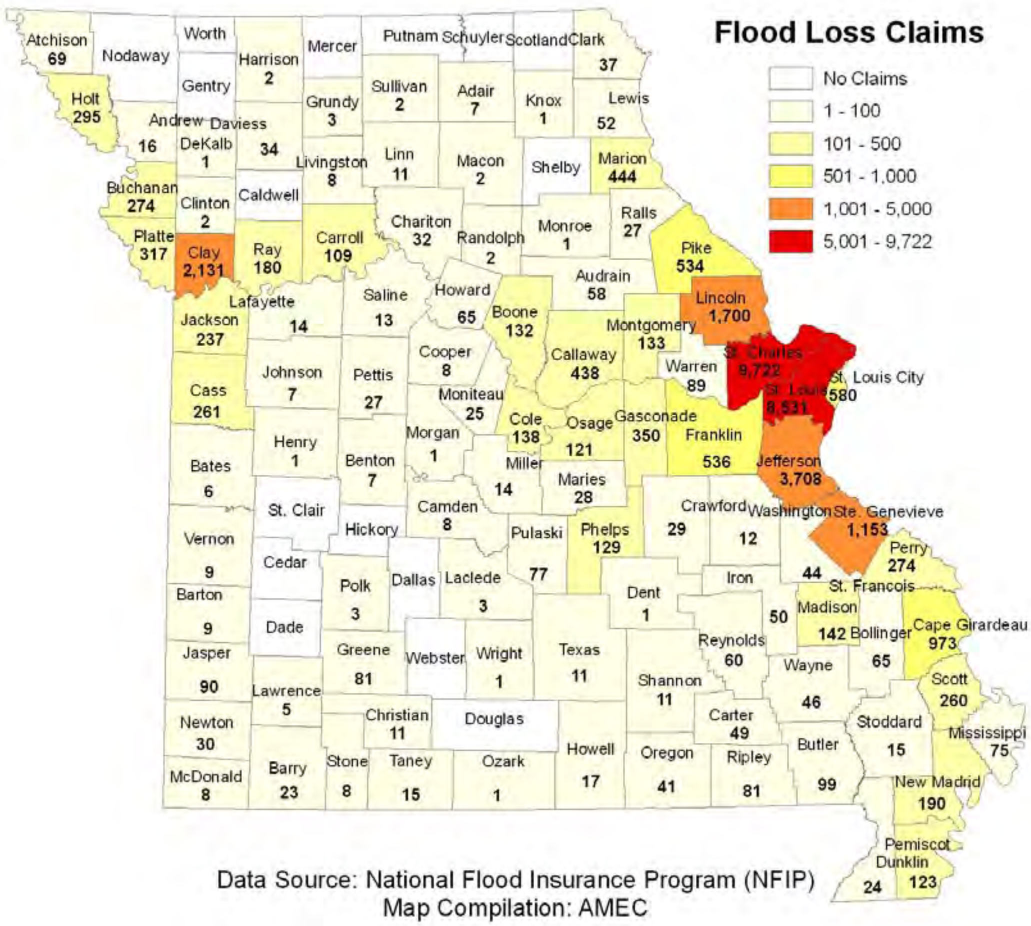


Figure 3.107. Flood Loss Claims in Missouri by County, 1978-2006



Repetitive Loss Property Analysis

A high priority in Missouri and nationwide is the reduction of losses to repetitive loss structures. These structures strain the National Flood Insurance Fund. They increase the NFIP's annual losses and the need for borrowing and, more importantly, they drain resources needed to prepare for catastrophic events. The NFIP defines a repetitive loss property as "any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. At least two of the claims must be more than 10-days apart."

The Flood Insurance Reform Act of 2004 identified another category of repetitive loss, severe repetitive loss, and defined it as "a single family property (consisting of one-to-four residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which four or more separate claims payments have been paid under flood insurance coverage with the amount of each claim payment exceeding $5,000 and with cumulative amount of such claims payments exceeding $20,000; or for which at least two separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property."

Table 3.78 and Figure 3.108 illustrate the number and location (county) of Missouri's repetitive loss properties. Table 3.78, which ranks number of losses by county, also shows loss ratios. Loss ratio is the number of losses divided by the number of properties. A higher loss ratio indicates a lower number of properties with a higher number of losses. The counties with the highest loss ratios (greater than 3.0) are highlighted. Table 3.79 lists the number of severe repetitive loss properties by county.

Table 3.78. Missouri's Repetitive Loss Property Summary

County	Losses	Properties	Loss Ratio
St. Charles*	2,171	579	3.7
Jefferson*	1,086	346	3.1
St. Louis*	1,010	320	3.2
Lincoln*	500	155	3.2
Pike*	145	37	3.9
Franklin*	123	49	2.5
St. Louis City	104	36	2.9
Gasconade*	98	27	3.6
Cole*	73	22	3.3
Platte*	41	18	2.3
Cape Girardeau*	39	14	2.8
Montgomery*	35	16	2.2
Osage*	21	10	2.1
Marion*	20	9	2.2
Ste. Genevieve*	20	7	2.9
Boone*	19	6	3.2
Warren*	19	9	2.1
Clay*	17	6	2.8
Buchanan*	16	7	2.3
Cass*	16	6	2.7
Scott*	15	7	2.1
Ray*	12	4	3.0
Butler*	11	5	2.2
Jackson*	11	3	3.7
Carroll*	10	4	2.5
Phelps*	10	5	2.0
Callaway*	8	4	2.0
Crawford*	8	4	2.0
Greene*	8	3	2.7
Pulaski*	8	4	2.0
Lafayette*	7	3	2.3
Reynolds*	7	3	2.3
Perry*	6	3	2.0
Jasper*	5	2	2.5
Mississippi*	5	2	2.5
Camden*	4	2	2.0
Ralls*	4	2	2.0

County	Losses	Properties	Loss Ratio
Ripley*	4	1	4.0
St. Francois*	4	2	2.0
Vernon*	4	2	2.0
Howard*	3	1	3.0
Maries*	3	1	3.0
Bollinger*	2	1	2.0
Chariton*	2	1	2.0
Grundy*	2	1	2.0
Holt*	2	1	2.0
Pemiscot*	2	1	2.0
Saline*	2	1	2.0

Source: National Flood Insurance Program, February 2007
Notes:
*These properties are reported to be in an unincorporated portion of the county
This report contains repetitive loss properties only; it does not include mitigated properties

Figure 3.108. Repetitive Flood Loss Properties by County, 1978-2006

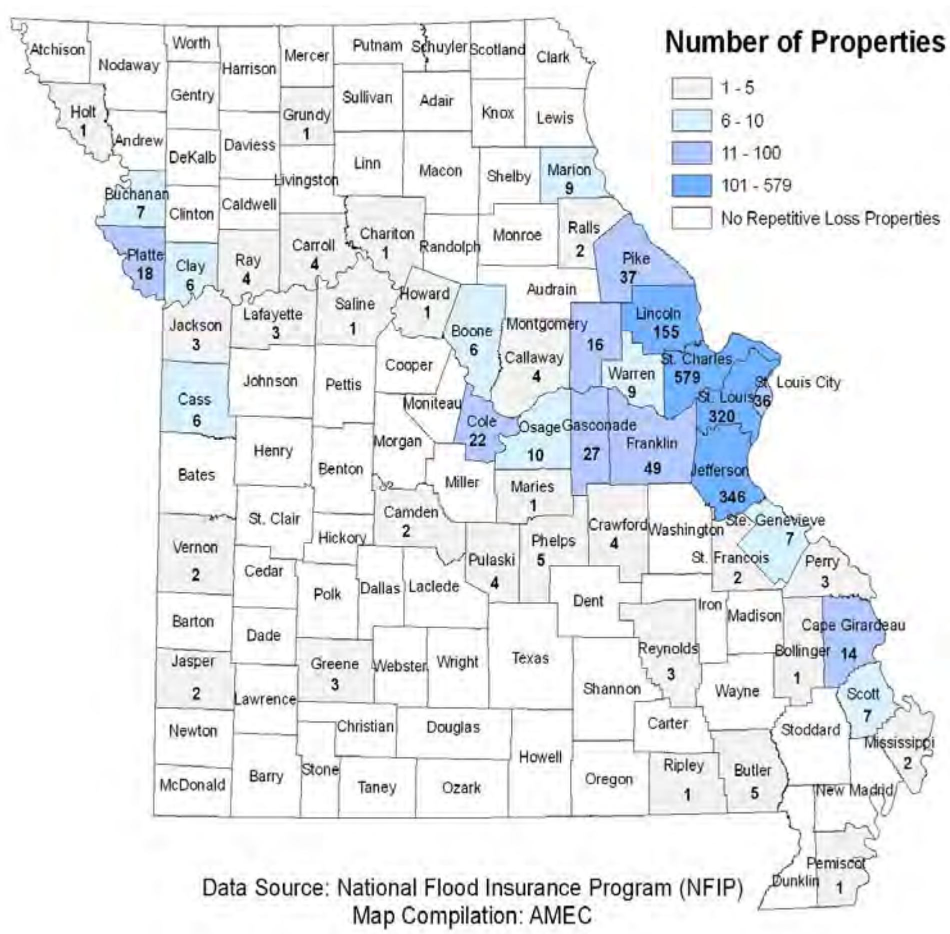


Table 3.79. Missouri's Severe Repetitive Loss (SRL) Property Summary

County	Validated SRL Residential	Validated SRL Nonresidential	Pending SRL Residential	Pending SRL Nonresidential
Boone	1			
Cape Girardeau	1			
Cole	1	1		
Gasconade	1		1	
Jackson	1			
Jefferson	8		11	2
Lincoln	1		1	
Platte			1	
Ray	1			
St. Charles	26	1	1	2
St. Louis	8	2		

Source: National Flood Insurance Program, March 2007
Notes:
Residential applies to single family properties (consisting of one-to-four residences)
Validated means a systematic review of the NFIP record for the property validated that the available insurance data supports the identification of the property as an SRL property.
Pending means a systematic review of the NFIP record for the property revealed a data anomaly that requires further investigation before the property can be validated as an SRL property.

3.3.4 Tornadoes

Note: For background information about tornadoes, see the profile in Section 3.2.9.

A statistical risk assessment methodology was used to determine annualized tornado losses by county. This methodology used National Oceanic and Atmospheric Administration (NOAA) data for tornado losses between 1950 and September 2006. It is important to realize that one limitation to this data is that many tornadoes that might have occurred in uninhabited areas, as well as some inhabited areas, have not been reported. The incompleteness of the data suggests that it is not appropriate for use in parametric modeling. In addition, NOAA data cannot show a realistic frequency distribution of different Fujita scale tornado events, except for recent years. Thus a parametric model based on a combination of many physical aspects of the tornado to predict future expected losses was not used. The statistical model used for this assessment was probabilistic based purely on tornado frequency and historic losses. It is based on past experience and forecasts the expected results for the immediate or extended future.

Methodology

The following steps were required to prepare the NOAA data for use with the methodology:

Data cleansing:

- Duplicate data that was reported by more than one jurisdiction was deleted.
- Data that was irrelevant to tornadoes (e.g., damage by lightning, thunderstorm, etc.) was deleted.

Data adjustment:

- The NOAA data is already adjusted for inflation and other economical effects.
- Observed losses were modified for increased or decreased level of exposure with regard to population growth history. Artificial occurrences of tornadoes were added to account for a disproportionate amount of occurrences that were not reported, based on an analysis of data in recent years. In addition, loss numbers were inflated (to normalize costs to current inventory and exposure values), which was assumed to increase proportionally with population growth. ly, the gradual decrease in the vulnerability of structures was considered (e.g., due to code upgrades/compliance, hazard mitigation, and the process of natural selection whereby some older construction survives over longer periods of time than others).

The approach to the 2007 update of tornado risk in Missouri included an update of the tornado events and annualized losses and an enhanced analysis and representation of the risk assessment results (see Table 3.80). The number of tornado occurrences was updated by adding the events that have been reported in each county since 2004 (through September 2006). After examining the increase in the total number of events, it was determined that the probability of a tornado occurrence in any given county would not change. This determination was made because the increase in events over the 19-month period January 2005–September 2006 was not significant enough to skew the entire 56-year dataset (1950-2006). To account for inflation and update the loss estimates, the state added 4 percent to the annualized historic loss averages presented in the 2004 version of this plan.

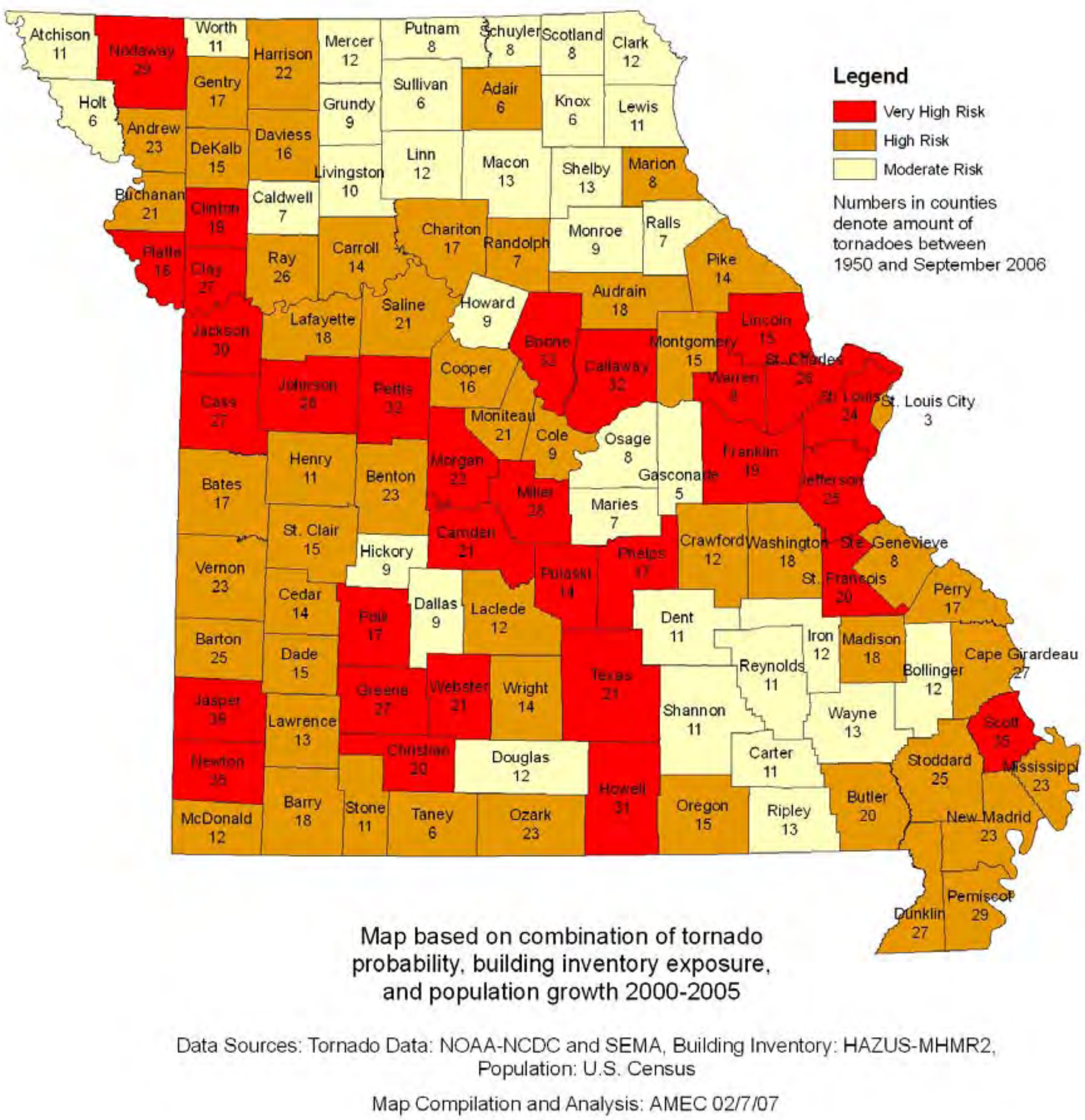
In this update, the state looked at several factors to determine tornado vulnerability. This vulnerability analysis measured the likelihood of future tornado impacts, potential building losses (exposure), and population change (percent change). Scales were created to rank these factors: likelihood (1-3), exposure (1-3), population change (1-3).[3] The factor scores were added up for each county for the purposes of ranking the counties by total risk with 8 being the highest score. This approach attempts to identify where tornadoes could have the greatest impacts. Devastating tornadoes could still impact counties that ranked lower in this process. For this reason, the low end of the risk is still considered Moderate and the top end Very High. Counties with a total risk score of 6 to 8 were considered to be at very high risk.

[3] Likelihood (number of events): 0-24=1, 25-49=2, 50-75=3
Exposure (dollar value, thousands): 100-1,100=1, 1,100-10,000=2, 10,000- 75,00=3
Population change (percent change): -8.7-5=1, 5-10=2, 10-24=3

Thirty-two counties were identified as very high risk and are shown in red in Figure 3.109, highlighted in Table 3.80, and listed alphabetically below:

Boone	Jasper	Platte
Callaway	Jefferson	Polk
Camden	Johnson	Pulaski
Cass	Lincoln	Scott
Christian	Miller	St. Charles
Clay	Morgan	St. Francois
Clinton	Newton	St. Louis County
Franklin	Nodaway	Texas
Greene	Pettis	Warren
Howell	Phelps	Webster
Jackson		

Figure 3.109. Missouri Tornado Risk Assessment



While this approach attempts to prioritize tornado vulnerable counties, it does not identify any particular geographic patterns to tornado risk. This is consistent with the random nature of tornadoes. Additional analysis tables were created that list the 12 counties with the largest annualized historic tornado losses between 1950 and 2005 and the 12 counties with the greatest likelihood of being impacted by a tornado. These are shown in Tables 3.81 and 3.82 respectively. Figure 3.110 shows a map of tornado probability by county (see Figure 3.61 for a map of Missouri tornadoes by county, 1950–2006). Another qualitative factor that is included in Table 3.80 is the Social Vulnerability Index (see Section 3.3.1 Assessing Vulnerability by Jurisdiction for an explanation). This index provides another measure of vulnerability to tornadoes.

Table 3.80. Tornado Probability, Potential Loss, and Risk Summary

County	# of Tornadoes 1950-2006	Likelihood of Occurrence 1950-2006	Total Exposure 2005	Annualized Historic Loss 1950-2005*	Loss Ratio	Rank by Loss Ratio	Social Vulnerability Index	Population Change % 2000-2005	Total Risk**
Adair	6	10.71%	$1,255,020,000	$5,108	0.000%	110	Low	-1.87%	high
Andrew	23	41.07%	$865,533,000	$201,550	0.023%	44	Medium-Low	2.47%	high
Atchison	11	19.64%	$325,720,000	$88,853	0.027%	39	High	-2.86%	moderate
Audrain	18	32.14%	$1,368,162,000	$183,980	0.013%	62	High	-0.36%	high
Barry	18	32.14%	$1,494,750,000	$298,829	0.020%	48	Low	4.67%	high
Barton	25	44.64%	$540,565,000	$903,330	0.167%	6	Medium	4.11%	high
Bates	17	30.36%	$742,734,000	$40,306	0.005%	81	Medium-High	2.25%	high
Benton	23	41.07%	$976,126,000	$207,588	0.021%	46	Medium-High	9.74%	high
Bollinger	12	21.43%	$497,879,000	$21,700	0.004%	84	Medium-Low	2.46%	moderate
Boone	32	57.14%	$7,912,796,000	$1,157,748	0.015%	59	Low	5.81%	very high
Buchanan	21	37.50%	$5,152,691,000	$118,761	0.002%	100	Medium-High	-1.27%	high
Butler	20	35.71%	$1,883,957,000	$458,706	0.024%	42	Medium-High	1.15%	high
Caldwell	7	12.50%	$381,131,000	$155,856	0.041%	33	Medium-Low	3.77%	moderate
Callaway	32	57.14%	$1,848,814,000	$36,154	0.002%	101	Low	4.35%	very high
Camden	21	37.50%	$3,612,511,000	$233,915	0.006%	77	Medium-Low	6.43%	very high
Cape Girardeau	27	48.21%	$4,071,532,000	$155,300	0.004%	87	Low	3.59%	high
Carroll	14	25.00%	$556,389,000	$128,710	0.023%	45	High	-0.89%	high
Carter	11	19.64%	$269,873,000	$493,757	0.183%	4	Medium-High	-0.52%	moderate
Cass	27	48.21%	$4,692,256,000	$2,074,565	0.044%	28	Medium-Low	14.79%	very high
Cedar	14	25.00%	$635,055,000	$1,100,340	0.173%	5	Medium-High	3.11%	high
Chariton	17	30.36%	$465,965,000	$262,815	0.056%	20	High	-3.72%	high
Christian	20	35.71%	$2,411,930,000	$685	0.000%	115	Low	23.91%	very high
Clark	12	21.43%	$332,397,000	$144,072	0.043%	30	Medium-High	-1.25%	moderate
Clay	27	48.21%	$12,766,168,000	$360,675	0.003%	95	Medium-Low	9.82%	very high
Clinton	19	33.93%	$1,099,740,000	$44,909	0.004%	85	Medium-High	9.15%	very high
Cole	9	16.07%	$4,302,655,000	$326,182	0.008%	72	Low	1.90%	high
Cooper	16	28.57%	$797,161,000	$51,662	0.006%	76	Low	3.74%	high
Crawford	12	21.43%	$1,116,986,000	$1,720,345	0.154%	7	Low	4.95%	high
Dade	15	26.79%	$338,141,000	$90,091	0.027%	41	High	-1.17%	high
Dallas	9	16.07%	$605,329,000	$3,346	0.001%	108	Medium-High	4.95%	moderate

County	# of Tornadoes 1950-2006	Likelihood of Occurrence 1950-2006	Total Exposure 2005	Annualized Historic Loss 1950-2005*	Loss Ratio	Rank by Loss Ratio	Social Vulnerability Index	Population Change % 2000-2005	Total Risk**
Daviess	16	28.57%	$400,972,000	$95,430	0.024%	43	Medium	1.31%	high
DeKalb	15	26.79%	$423,855,000	$19,259	0.005%	83	Low	6.42%	high
Dent	11	19.64%	$696,334,000	$31,744	0.005%	82	Medium-High	1.05%	moderate
Douglas	12	21.43%	$475,515,000	$199,273	0.042%	32	Medium-Low	3.90%	moderate
Dunklin	27	48.21%	$1,247,551,000	$730,618	0.059%	19	High	-1.84%	high
Franklin	19	33.93%	$5,194,361,000	$359,686	0.007%	73	Medium-Low	5.63%	very high
Gasconade	5	8.93%	$838,880,000	$1,243,448	0.148%	8	Medium	2.63%	moderate
Gentry	17	30.36%	$351,825,000	$14,222	0.004%	86	Low	-4.46%	high
Greene	27	48.21%	$13,728,071,000	$2,412,752	0.018%	54	Medium-Low	4.32%	very high
Grundy	9	16.07%	$510,992,000	$16,669	0.003%	91	Medium-High	-1.01%	moderate
Harrison	22	39.29%	$445,488,000	$230,865	0.052%	25	Medium	0.29%	high
Henry	11	19.64%	$1,173,322,000	$159,399	0.014%	61	Medium	2.64%	high
Hickory	9	16.07%	$425,436,000	$25,308	0.006%	80	High	3.70%	moderate
Holt	6	10.71%	$274,294,000	$928	0.000%	111	Medium-High	-5.05%	moderate
Howard	9	16.07%	$439,617,000	$16,349	0.004%	88	Low	-2.50%	moderate
Howell	31	55.36%	$1,477,566,000	$1,236,558	0.084%	16	Medium	3.12%	very high
Iron	12	21.43%	$455,591,000	$151,613	0.033%	38	High	-3.96%	moderate
Jackson	30	53.57%	$45,083,895,000	$1,136,716	0.003%	97	High	1.23%	very high
Jasper	39	69.64%	$5,273,119,000	$770,093	0.015%	60	Medium	5.67%	very high
Jefferson	25	44.64%	$10,632,699,000	$317,449	0.003%	94	Medium-Low	7.86%	very high
Johnson	28	50.00%	$2,812,165,000	$52,281	0.002%	102	Low	5.23%	very high
Knox	6	10.71%	$227,631,000	$29,544	0.013%	63	High	-4.36%	moderate
Laclede	12	21.43%	$1,509,600,000	$164,357	0.011%	66	Medium-Low	6.09%	high
Lafayette	18	32.14%	$1,840,700,000	$124,617	0.007%	75	Medium	0.45%	high
Lawrence	13	23.21%	$1,475,037,000	$149,528	0.010%	68	Medium-Low	5.46%	high
Lewis	11	19.64%	$422,794,000	$83,616	0.020%	49	Medium	-2.94%	moderate
Lincoln	15	26.79%	$1,785,378,000	$53,389	0.003%	93	Low	22.55%	very high
Linn	12	21.43%	$641,269,000	$173,938	0.027%	40	High	-4.52%	moderate
Livingston	10	17.86%	$714,430,000	$10,274	0.001%	105	High	-1.83%	moderate
Macon	13	23.21%	$710,264,000	$313,691	0.044%	29	Medium-High	-1.03%	moderate
Madison	18	32.14%	$552,613,000	$38,041	0.007%	74	High	2.97%	high
Maries	7	12.50%	$387,732,000	$14,057	0.004%	89	Medium-Low	0.97%	moderate

County	# of Tornadoes 1950-2006	Likelihood of Occurrence 1950-2006	Total Exposure 2005	Annualized Historic Loss 1950-2005*	Loss Ratio	Rank by Loss Ratio	Social Vulnerability Index	Population Change % 2000-2005	Total Risk**
Marion	8	14.29%	$1,567,118,000	$9,756	0.001%	106	Medium-High	0.30%	high
McDonald	12	21.43%	$729,267,000	$47,051	0.006%	78	Low	5.36%	high
Mercer	12	21.43%	$196,352,000	$109,165	0.056%	22	Medium-High	-4.31%	moderate
Miller	28	50.00%	$1,097,168,000	$168,208	0.015%	58	Medium-High	4.87%	very high
Mississippi	23	41.07%	$567,060,000	$702,570	0.124%	10	High	1.28%	high
Moniteau	21	37.50%	$661,922,000	$970,270	0.147%	9	Low	1.73%	high
Monroe	9	16.07%	$403,057,000	$1,281	0.000%	112	Medium	0.73%	moderate
Montgomery	15	26.79%	$680,980,000	$21,361	0.003%	92	Medium	0.25%	high
Morgan	22	39.29%	$1,271,590,000	$35,844	0.003%	96	Medium-Low	5.84%	very high
New Madrid	23	41.07%	$850,397,000	$721,266	0.085%	15	High	-6.04%	high
Newton	35	62.50%	$2,353,965,000	$1,322,999	0.056%	21	Low	5.54%	very high
Nodaway	29	51.79%	$1,112,952,000	$216,078	0.019%	51	Low	-0.92%	very high
Oregon	15	26.79%	$394,601,000	$322,989	0.082%	17	Medium	0.57%	high
Osage	8	14.29%	$785,519,000	$130,186	0.017%	55	Medium-Low	3.24%	moderate
Ozark	23	41.07%	$399,368,000	$1,025,966	0.257%	2	Medium-High	-0.54%	high
Pemiscot	29	51.79%	$807,586,000	$67,896	0.008%	70	High	-3.17%	high
Perry	17	30.36%	$1,088,488,000	$1,141,772	0.105%	11	Medium	2.42%	high
Pettis	32	57.14%	$2,127,437,000	$2,103,229	0.099%	14	Medium-Low	1.82%	very high
Phelps	17	30.36%	$1,916,886,000	$181,298	0.009%	69	Low	5.78%	very high
Pike	14	25.00%	$850,056,000	$19,914	0.002%	98	Low	2.24%	high
Platte	18	32.14%	$4,908,320,000	$780,856	0.016%	57	Medium-High	11.25%	very high
Polk	17	30.36%	$1,146,697,000	$204,731	0.018%	52	Low	7.04%	very high
Pulaski	14	25.00%	$2,056,690,000	$339,428	0.017%	56	Medium-Low	7.34%	very high
Putnam	8	14.29%	$236,755,000	$697	0.000%	113	High	-1.05%	moderate
Ralls	7	12.50%	$473,162,000	$257,444	0.054%	23	Low	1.40%	moderate
Randolph	7	12.50%	$1,263,909,000	$21,668	0.002%	103	Medium-High	2.73%	high
Ray	26	46.43%	$1,230,761,000	$425,579	0.035%	37	Medium-Low	3.20%	high
Reynolds	11	19.64%	$341,902,000	$20,577	0.006%	79	Medium	-1.55%	moderate
Ripley	13	23.21%	$506,849,000	$191,794	0.038%	34	Medium	2.53%	moderate
Saline	21	37.50%	$1,276,194,000	$29,832	0.002%	99	Medium-Low	-2.87%	high
Schuyler	8	14.29%	$188,884,000	$118,379	0.063%	18	High	3.31%	moderate
Scotland	8	14.29%	$235,585,000	$18,921	0.008%	71	Medium-High	-1.10%	moderate

County	# of Tornadoes 1950-2006	Likelihood of Occurrence 1950-2006	Total Exposure 2005	Annualized Historic Loss 1950-2005*	Loss Ratio	Rank by Loss Ratio	Social Vulnerability Index	Population Change % 2000-2005	Total Risk**
Scott	35	62.50%	$1,958,607,000	$1,046,154	0.053%	24	Medium-High	1.78%	very high
Shannon	11	19.64%	$301,246,000	$141,352	0.047%	26	High	0.52%	moderate
Shelby	13	23.21%	$333,722,000	$121,056	0.036%	36	Medium	-0.81%	moderate
St. Charles	26	46.43%	$17,675,776,000	$1,897,421	0.011%	67	Medium	16.22%	very high
St. Clair	15	26.79%	$435,085,000	$1,082,019	0.249%	3	High	0.35%	high
St. Francois	20	35.71%	$2,765,917,000	$1,250,791	0.045%	27	Medium	10.82%	very high
St. Louis	24	42.86%	$75,239,760,000	$434,199	0.001%	107	High	-1.10%	very high
St. Louis City	3	5.36%	$23,209,115,000	$11,103	0.000%	114	Medium-High	-1.15%	high
Ste. Genevieve	8	14.29%	$1,032,875,000	$1,029,102	0.100%	13	Medium	2.00%	high
Stoddard	25	44.64%	$1,266,590,000	$152,364	0.012%	64	Medium	0.03%	high
Stone	11	19.64%	$1,480,692,000	$50,508	0.003%	90	Medium	7.93%	high
Sullivan	6	10.71%	$319,193,000	$1,541	0.000%	109	Medium-Low	-4.32%	moderate
Taney	6	10.71%	$2,182,786,000	$33,440	0.002%	104	Medium-Low	8.27%	high
Texas	21	37.50%	$1,016,675,000	$369,150	0.036%	35	High	7.00%	very high
Vernon	23	41.07%	$1,012,381,000	$1,013,914	0.100%	12	Medium	-0.06%	high
Warren	8	14.29%	$1,358,958,000	$267,700	0.020%	50	Low	17.28%	very high
Washington	18	32.14%	$804,605,000	$2,321,223	0.288%	1	Medium-Low	2.95%	high
Wayne	13	23.21%	$616,116,000	$128,651	0.021%	47	Medium-High	-1.22%	moderate
Webster	21	37.50%	$1,345,594,000	$239,200	0.018%	53	Medium-Low	11.92%	very high
Worth	11	19.64%	$121,911,000	$13,394	0.011%	65	High	-8.73%	moderate
Wright	14	25.00%	$723,944,000	$313,687	0.043%	31	Medium	1.95%	high

Sources: NOAA National Climatic Data Center Storm Event Database and supplemented with data from SEMA (through September 30, 2006); HAZUS-MH, 2005 (Total Exposure 2005); USC Hazards and Vulnerability Research Institute (based on 2000 U.S. Census Bureau data); U.S. Census Bureau, 2006

Notes:

*4 percent added to dollar amounts in original plan to account for inflation.

**Total risk is based on likelihood, exposure, and growth.

Shaded counties represent counties with greatest risk (top 31).

Table 3.81. Top 10 Counties Ranked by Annualized Historic Tornado Loss 1950-2005

County	Annualized Historic Loss 1950-2005*
Greene	$2,412,752
Washington	$2,321,223
Pettis	$2,103,229
Cass	$2,074,565
St. Charles	$1,897,421
Crawford	$1,720,345
Newton	$1,322,999
St. Francois	$1,250,791
Gasconade	$1,243,448
Howell	$1,236,558
Boone	$1,157,748
Perry	$1,141,772

Note:
*4 percent added to dollar amounts in the 2004 version of this plan to account for inflation.
Source: NOAA National Climatic Data Center Storm Event Database

Table 3.82. Top 10 Counties Ranked by Number of Tornadoes/ Likelihood of Occurrence 1950-2006

County	# of Tornadoes 1950-2006	Likelihood of Occurrence 1950-2006
Jasper	39	69.64%
Newton	35	62.50%
Scott	35	62.50%
Boone	32	57.14%
Callaway	32	57.14%
Pettis	32	57.14%
Howell	31	55.36%
Jackson	30	53.57%
Nodaway	29	51.79%
Pemiscot	29	51.79%
Johnson	28	50.00%
Miller	28	50.00%

Source: NOAA National Climatic Data Center Storm Event Database and SEMA (through September 30, 2006)

Figure 3.110. Missouri Tornado Probability

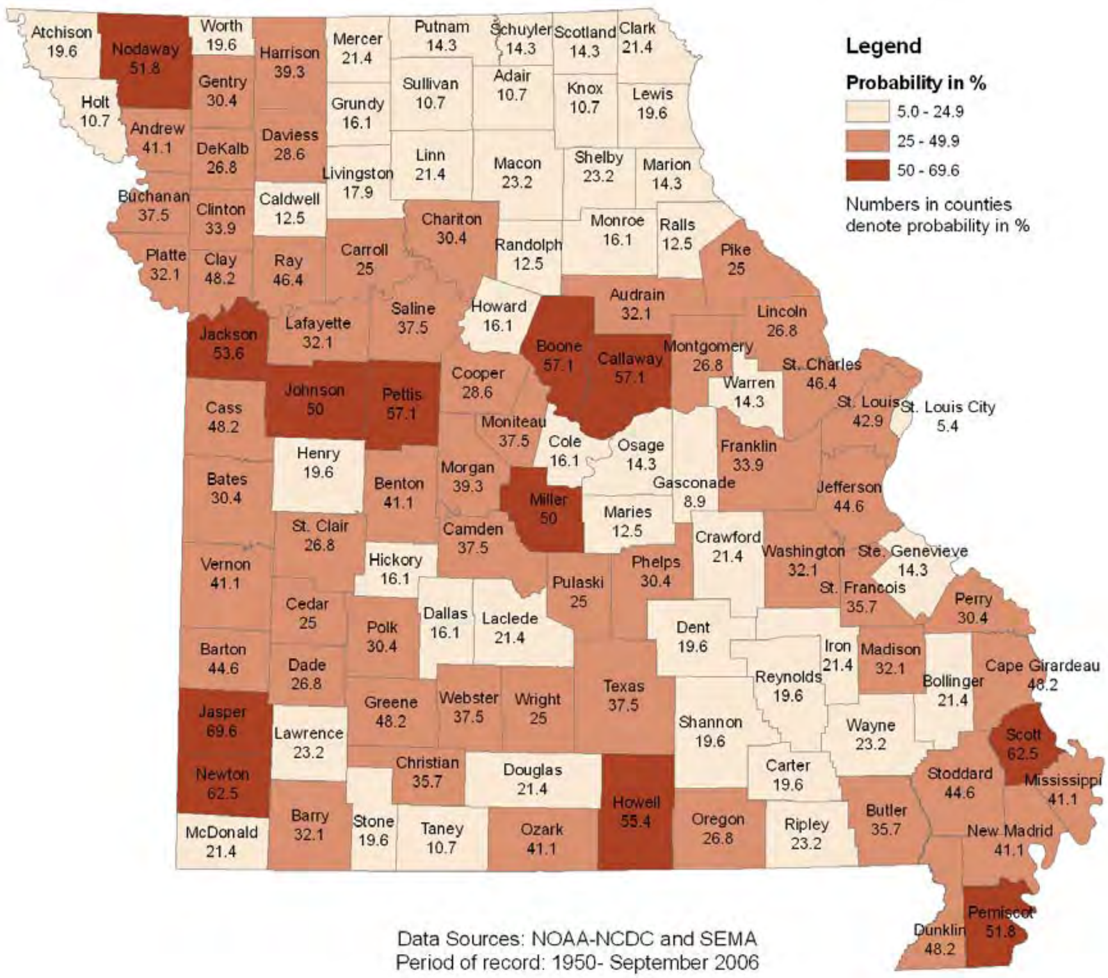


Figure 3.111 illustrates the frequency of tornadoes by decade since 1950 and reveals that older NOAA data (e.g., 1950s and 1960s) is poor at reporting lower intensity tornadoes that likely have produced (noticeable) losses. Figure 3.112 presents a map of the reported historical tornadoes that have impacted Missouri counties. The map illustrates a strong correlation between the occurrences of reported tornadoes in areas of high population density.

Figure 3.111. Tornado Frequency Histogram

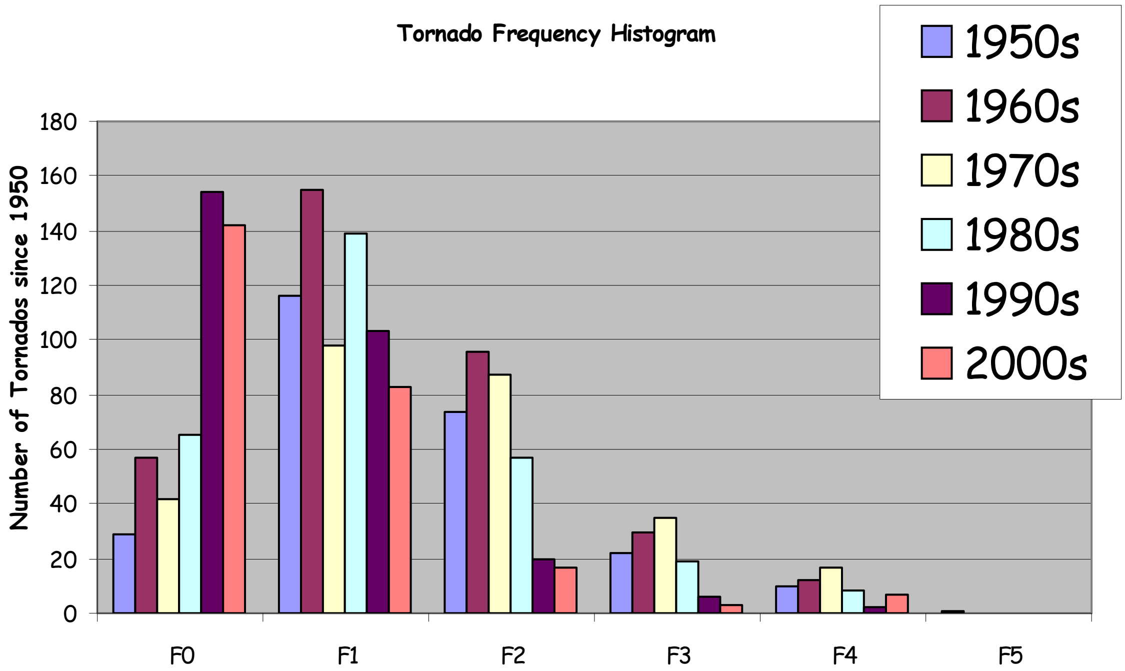
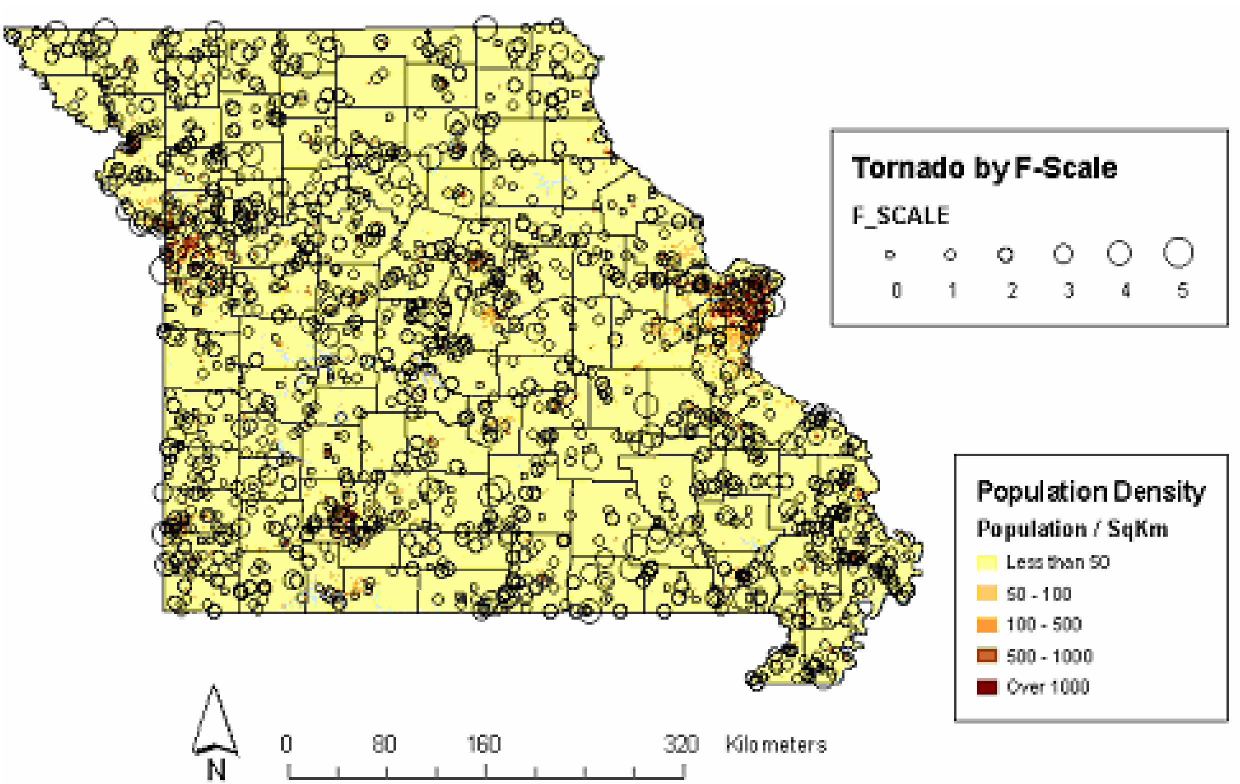


Figure 3.112. Historical Tornado Events (NOAA Data 1950–2003)



3.3.5 Earthquakes

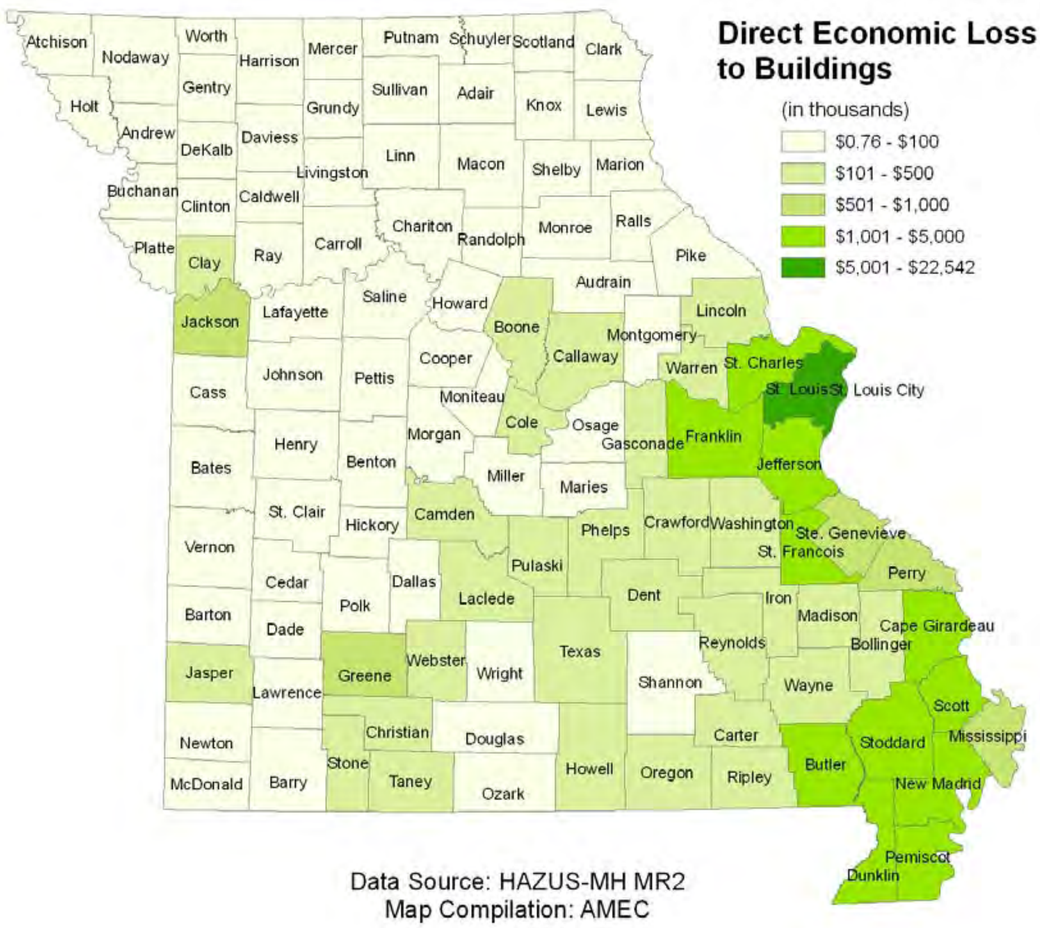
Note: For background information about earthquakes, see the profile in Section 3.2.3.

As part of the risk assessment update, two new analyses were run with HAZUS-MH to estimate potential losses from earthquakes. All HAZUS-MH runs used the default inventory data associated with the May 2006 release of HAZUS-MH MR2, which includes 2005 building valuations. An annualized loss scenario that enabled an "apples to apples" comparison of earthquake risk for each county was run. A second scenario, based on event with a 2,500 year return period, was done to model a worst case earthquake using a level of ground shaking recognized in earthquake-resistant design.

Annualized Loss Scenario

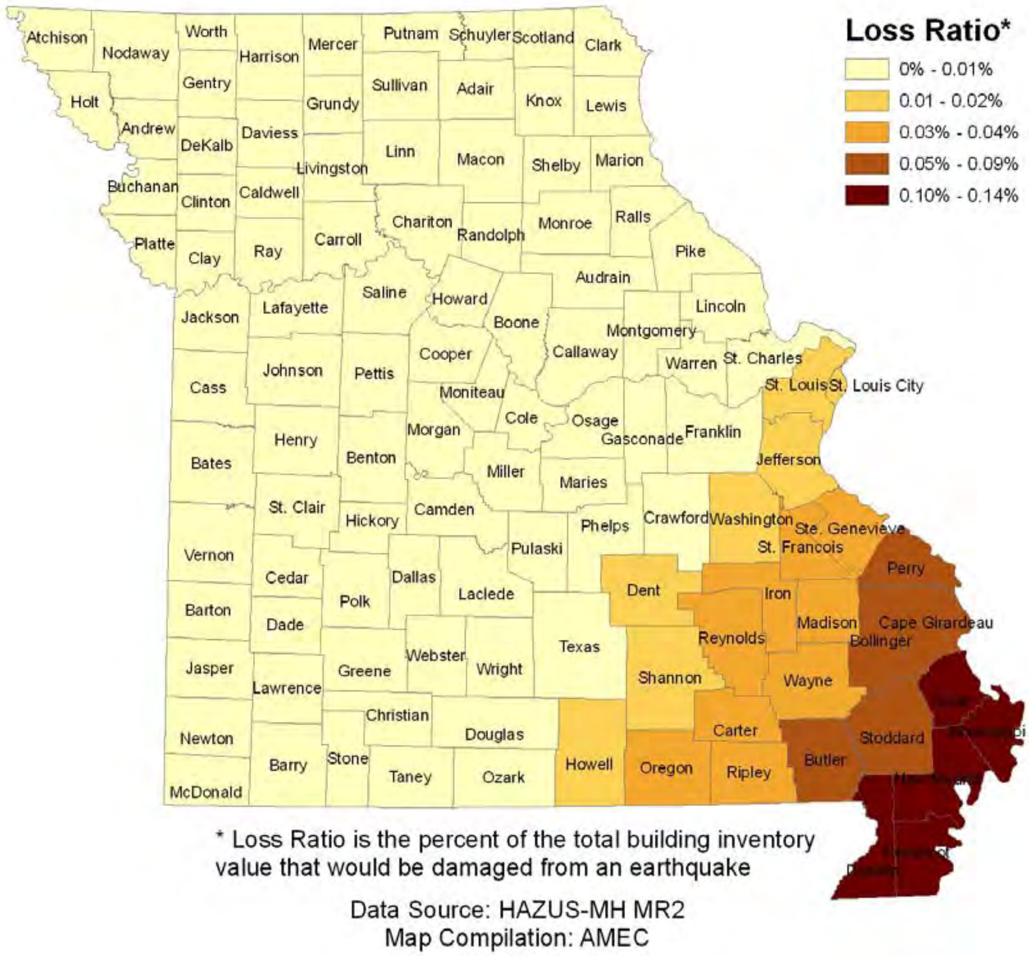
The results of the updated annualized loss scenario are shown in Figures 3.113 and 3.114. The map in Figure 3.113 shows direct economic losses to buildings annualized over eight earthquake return periods (100, 200, 500, 750, 1,000, 1,500, 2,000, and 2,500 years). The trend shows dollar losses to be most significant in the southeastern portion of the state and in the urbanized areas near St. Louis. This is consistent with the southeastern portion of the state's proximity to the New Madrid Seismic Zone and the fact that the more developed areas in the region are likely to suffer the most building losses, particularly where there are large numbers of unreinforced masonry buildings.

Figure 3.113. HAZUS-MH Earthquake Loss Estimation: Annualized Loss Scenario—Direct Economic Losses to Buildings



The loss-ratio map in Figure 3.114 represents the ratio of the average annualized losses divided by the entire building inventory by county. The loss ratio is an indication of the economic impacts an earthquake could have, and how difficult it could be for a particular community to recover from an event. The map indicates that the highest risk is to the counties closest to the New Madrid Seismic Zone, which are likely to have considerable portions of the building inventory damaged during an earthquake.

Figure 3.114. HAZUS-MH Earthquake Loss Estimation: Annualized Loss Scenario—Loss Ratio



The total annualized expected losses (including building and income losses) are presented in Table 3.83 and ranked from highest total losses to lowest. Included in the table are the annualized loss ratio and a ranking based on this loss ratio. The top 10 counties in terms of the highest annualized loss ratio are highlighted. The table also compares annualized earthquake losses against annualized tornado losses.

A modification to the default HAZUS-MH seismic design building occupancy mapping was made for this analysis. HAZUS-MH assigns seismic design levels to all the building stock associated with a particular census tract. Default HAZUS-MH design levels assigned to census tracts used a combination of two types: MO1—Missouri low seismic design and MO2—Missouri moderate seismic design. MO2 assumes that the majority of structures have moderate seismic design levels incorporated into the building stock of a particular census tract. Since seismic code provisions have only recently been required in Missouri for new construction in certain counties, it is likely that most of the existing building stock is MO1, of low seismic design. (This does not mean that buildings using seismic design, such as the International

Building Code 2003, will not be damaged or destroyed. The codes only address life safety, not building survivability.) This parameter in HAZUS-MH was changed so that all census tracts were assigned to MO1. Total annualized losses for the state are $77,654,000 with this modification and $73,337,000 with the default mix of low and moderate design. The difference, $4,317,000, represents a measure of average annualized savings from earthquake losses from the use of building codes with seismic provisions. As a result of this effort, this modification is being incorporated into HAZUS-MH runs that FEMA is conducting for its 2007 catastrophic planning initiative.

Table 3.83 HAZUS-MH Earthquake Loss Estimation: Annualized Loss Scenario (Results Ranked by Total Loss and Compared to Annualized Tornado Loss)*

County	Building Loss Total	Loss Ratio**	Income Loss Total	Total Loss	Loss Ratio Rank	Tornado Loss***
St. Louis	$22,543	0.02	$3,574	$26,117	24	$434
St. Louis City	$8,051	0.03	$1,518	$9,569	22	$11
Cape Girardeau	$3,956	0.08	$560	$4,516	7	$155
St. Charles	$3,723	0.02	$518	$4,242	29	$1,897
Jefferson	$3,613	0.03	$423	$4,036	21	$317
Scott	$2,985	0.12	$367	$3,352	4	$1,046
Dunklin	$1,595	0.10	$200	$1,795	5	$731
Butler	$1,474	0.06	$281	$1,755	8	$459
Stoddard	$1,482	0.09	$161	$1,643	6	$152
New Madrid	$1,462	0.14	$167	$1,629	2	$721
Pemiscot	$1,359	0.13	$152	$1,512	3	$68
St. Francois	$1,291	0.04	$200	$1,490	16	$1,251
Franklin	$1,130	0.02	$159	$1,289	28	$360
Greene	$869	0.01	$272	$1,141	51	$2,413
Mississippi	$981	0.14	$94	$1,075	1	$703
Perry	$746	0.05	$95	$841	10	$1,142
Jackson	$615	0.00	$163	$778	94	$1,137
Ste. Genevieve	$541	0.04	$69	$610	14	$1,029
Howell	$416	0.02	$81	$497	25	$1,237
Boone	$375	0.00	$109	$484	60	$1,158
Wayne	$376	0.05	$45	$420	11	$129
Bollinger	$352	0.06	$35	$387	9	$22
Phelps	$320	0.01	$61	$382	32	$181
Madison	$320	0.05	$41	$361	13	$38
Cole	$282	0.01	$72	$354	49	$326
Ripley	$309	0.05	$39	$348	12	$192
Taney	$235	0.01	$107	$342	41	$33
Pulaski	$285	0.01	$52	$337	33	$339
Washington	$290	0.03	$38	$328	20	$2,321
Crawford	$241	0.02	$38	$279	27	$1,720
Lincoln	$227	0.01	$33	$260	38	$53
Camden	$197	0.00	$55	$252	55	$234
Texas	$193	0.02	$37	$230	30	$369

County	Building Loss Total	Loss Ratio**	Income Loss Total	Total Loss	Loss Ratio Rank	Tornado Loss***
Iron	$203	0.04	$25	$228	17	$152
Dent	$188	0.02	$31	$219	26	$32
Warren	$191	0.01	$26	$217	34	$268
Clay	$159	0.00	$34	$192	95	$361
Jasper	$141	0.00	$41	$182	77	$770
Christian	$154	0.01	$26	$179	50	$1
Laclede	$140	0.01	$31	$171	44	$164
Oregon	$149	0.03	$21	$170	19	$323
Reynolds	$149	0.03	$19	$168	18	$21
Carter	$137	0.04	$19	$156	15	$494
Webster	$124	0.01	$19	$143	43	$239
Callaway	$123	0.01	$19	$142	47	$36
Gasconade	$117	0.01	$18	$136	35	$1,243
Stone	$108	0.01	$25	$133	46	$51
Wright	$99	0.01	$18	$117	36	$314
Shannon	$98	0.03	$16	$114	23	$141
Barry	$87	0.00	$20	$107	54	$299
Osage	$90	0.01	$13	$104	40	$130
Audrain	$83	0.00	$20	$102	53	$184
Newton	$74	0.00	$19	$93	72	$1,323
Marion	$71	0.00	$20	$91	63	$10
Pike	$71	0.01	$15	$86	45	$20
Ozark	$74	0.02	$12	$86	31	$1,026
Lawrence	$69	0.00	$15	$84	62	$150
Miller	$71	0.01	$13	$84	48	$168
Johnson	$67	0.00	$14	$81	80	$52
Pettis	$64	0.00	$16	$80	75	$2,103
Montgomery	$68	0.01	$11	$78	42	$21
Morgan	$62	0.00	$13	$74	59	$36
Cass	$63	0.00	$9	$73	93	$2,075
Polk	$58	0.00	$13	$70	56	$205
Douglas	$60	0.01	$9	$69	37	$199
Buchanan	$54	0.00	$16	$69	100	$119
Platte	$57	0.00	$10	$66	98	$781
Maries	$49	0.01	$6	$55	39	$14
Randolph	$41	0.00	$11	$53	69	$22
Dallas	$37	0.01	$7	$44	52	$3
Benton	$36	0.00	$7	$43	67	$208
Lafayette	$32	0.00	$6	$38	88	$125
Saline	$30	0.00	$7	$36	81	$30
Moniteau	$31	0.00	$5	$36	61	$970
Cooper	$29	0.00	$7	$36	68	$52
McDonald	$29	0.00	$6	$35	65	$47
Henry	$28	0.00	$7	$35	79	$159
Ralls	$23	0.00	$3	$27	57	$257
Vernon	$22	0.00	$5	$27	84	$1,014

County	Building Loss Total	Loss Ratio**	Income Loss Total	Total Loss	Loss Ratio Rank	Tornado Loss***
Adair	$19	0.00	$7	$26	91	$5
Cedar	$19	0.00	$4	$23	74	$1,100
Hickory	$20	0.00	$3	$23	58	$25
Monroe	$17	0.00	$3	$20	64	$1
Macon	$14	0.00	$4	$18	85	$314
Ray	$15	0.00	$2	$17	96	$426
Bates	$14	0.00	$3	$16	87	$40
Barton	$13	0.00	$3	$16	78	$903
St. Clair	$13	0.00	$3	$16	71	$1,082
Howard	$14	0.00	$2	$16	70	$16
Dade	$13	0.00	$2	$15	66	$90
Lewis	$12	0.00	$2	$14	76	$84
Clinton	$11	0.00	$2	$13	104	$45
Chariton	$10	0.00	$2	$12	83	$263
Shelby	$10	0.00	$2	$12	73	$121
Linn	$10	0.00	$2	$12	92	$174
Carroll	$9	0.00	$2	$11	89	$129
Livingston	$8	0.00	$2	$11	97	$10
Nodaway	$9	0.00	$2	$11	111	$216
Clark	$7	0.00	$1	$9	82	$144
Andrew	$7	0.00	$1	$8	110	$202
Grundy	$4	0.00	$1	$5	108	$17
Knox	$4	0.00	$1	$5	86	$30
Scotland	$4	0.00	$1	$5	90	$19
DeKalb	$4	0.00	$1	$4	106	$19
Caldwell	$4	0.00	$1	$4	101	$156
Daviess	$3	0.00	$1	$4	107	$95
Sullivan	$3	0.00	$1	$4	102	$2
Atchison	$3	0.00	$1	$4	105	$89
Harrison	$3	0.00	$1	$4	114	$231
Holt	$3	0.00	$1	$3	103	$1
Gentry	$3	0.00	$1	$3	112	$14
Schuyler	$2	0.00	$0	$3	99	$118
Putnam	$2	0.00	$0	$2	109	$1
Mercer	$1	0.00	$0	$2	113	$109
Worth	$1	0.00	$0	$1	115	$13

Source: HAZUS-MH MR2; NOAA National Climatic Data Center Storm Event Database and supplemented with data from SEMA (through September 30, 2006)
Notes:
*All $ values are in thousands
**Loss ratio is the direct building losses divided by the entire building inventory value within a county
***4 percent added to dollar amounts in the 2004 version of this plan to account for inflation

2,500 Year Earthquake Scenario

A second scenario, based on an event with a 2,500 year return period, was done to model a worst case scenario. The methodology includes probabilistic seismic hazard contour maps developed

by the U.S. Geological Survey (USGS) for the 2002 update of the National Seismic Hazard Maps that are included with HAZUS-MH. The USGS maps provide estimates of potential ground acceleration and spectral acceleration at periods of 0.3 second and 1.0 second, respectively. The 2,500 year return period analyzes ground shaking estimates with a 2 percent probability of being exceeded in 50 years. The International Building Code uses this level of ground shaking for building design in seismic areas. The building code classifications in HAZUS-MH were set to low design throughout the state for this scenario as well.

Scenario Results

The results of this probabilistic scenario include total losses exceeding $44 billion in building and income losses, with overall economic losses exceeding $58 billion. Over 27 percent of the total number of buildings in the state would be at least moderately damaged. Thirteen percent of the building and income losses would be related to business interruption. Table 3.84 summarizes the results from the HAZUS-MH run for the entire state (HAZUS-MH Earthquake Event Summary Report). Table 3.85 summarizes the building related losses by county. Figure 3.115 depicts a map of the modeled earthquake impacts by county based on building losses, including structural and nonstructural damage, content and inventory loss, and wage and income loss. Figure 3.116 depicts loss ratio by county, which is the ratio of the building structure and nonstructural damage to the value of the entire building inventory. The loss ratio is a measure of the disaster impact to community sustainability, which is generally considered at risk when losses exceed 10 percent of the built environment (FEMA). The loss-ratio map depicts considerable losses in southeastern Missouri, which is consistent with this area's close proximity to the New Madrid Seismic Zone and high liquefaction potential.

Limitations to the HAZUS-MH loss modeling include inability to accurately assess the impact to long-span bridges, such as those crossing the Mississippi River. Damage to major infrastructure, such as power and other utility distribution systems, is estimated based on a proxy of the population within the study area and not on actual data representing these systems.

Improvements to future HAZUS-MH runs may include using more extensive geologic mapping (as it becomes available), using more extensive ground shaking mapping, adding utilities infrastructure, and adding groundwater depth maps to the analysis. More extensive geologic and ground shaking mapping north of St. Louis would enable more accurate representation of the earthquake hazard in northeastern Missouri.

Table 3.84. HAZUS-MH Earthquake Loss Estimation
2,500-Year Scenario Results Summary of Overall Impacts

Type of Impact	Impacts to Region
Total Buildings Damaged	Slight: 368,535 Moderate: 282,755 Extensive: 124,148 Complete: 71,548
Building and Income Related Losses	$44.3 billion
Total Economic Losses (includes building, income and lifeline losses)	$58.2 billion
Casualties (based on 2 a.m. time of occurrence)	Without requiring hospitalization: 32,512 Requiring hospitalization: 8,439 Life threatening: 1,147 Fatalities: 2,227
Casualties (based on 2 p.m. time of occurrence)	Without requiring hospitalization: 32,163 Requiring hospitalization: 8,769 Life threatening: 1,314 Fatalities: 2,477
Casualties (based on 5 p.m. time of occurrence)	Without requiring hospitalization: 29,326 Requiring hospitalization: 8,310 Life threatening: 1,965 Fatalities: 2,314
Damage to Schools	1,256 with at least moderate damage
Damage to Hospitals	56 with at least moderate damage
Damage to Transportation Systems	1,881 highway bridges, at least moderate damage 809 highway bridges, complete damage 4 railroad bridges, moderate damage 41 airport facilities, moderate damage
Households without Power/Water Service (based on 2,194,594 households)	Power loss, Day 1: 668,150 Water loss, Day 1: 98,999 Water loss, Day 3: 75,116 Water loss, Day 7: 59,793 Water loss, Day 30: 35,146 Water loss, Day 90: 0
Displaced Households	100,132
Shelter Requirements	26,833 people out of 5,595,211 total population in region
Debris Generation	24 million tons

Source: HAZUS-MH MR2

Figure 3.115. HAZUS-MH Earthquake Loss Estimation 2,500-Year Scenario—Total Building Loss

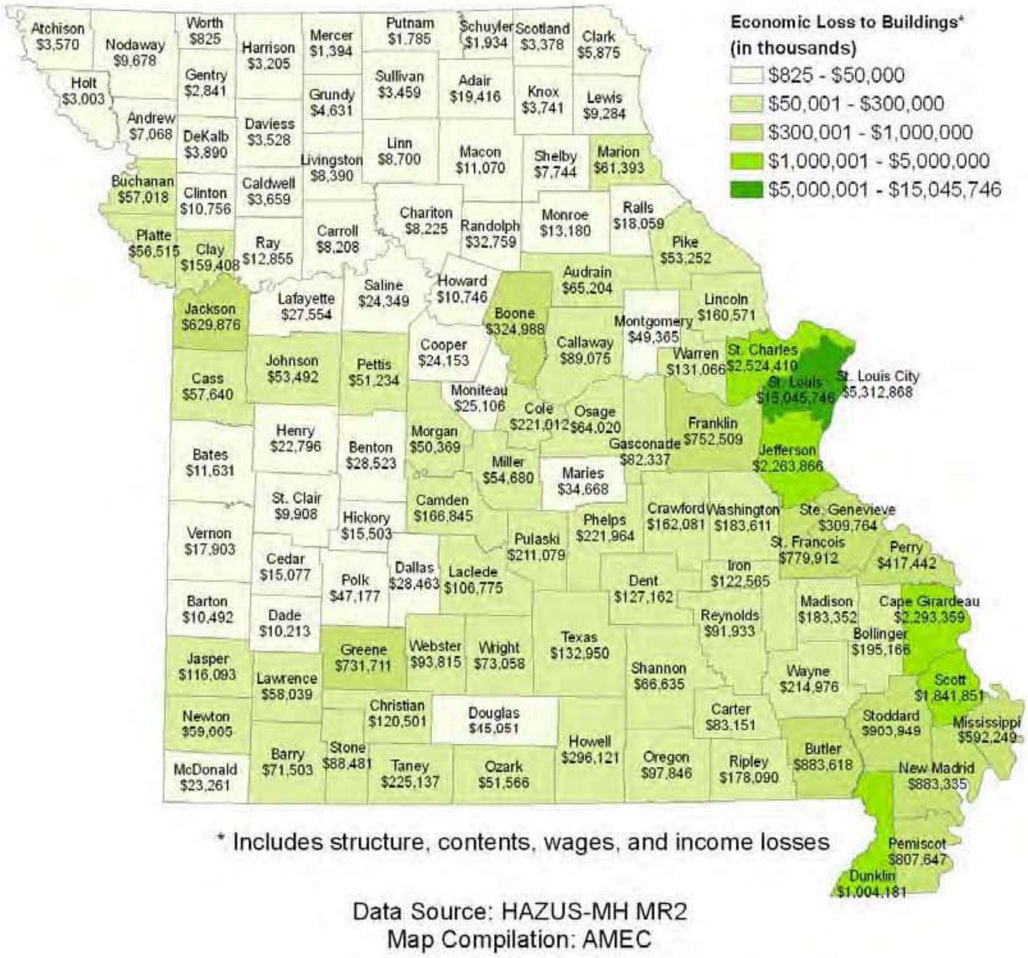
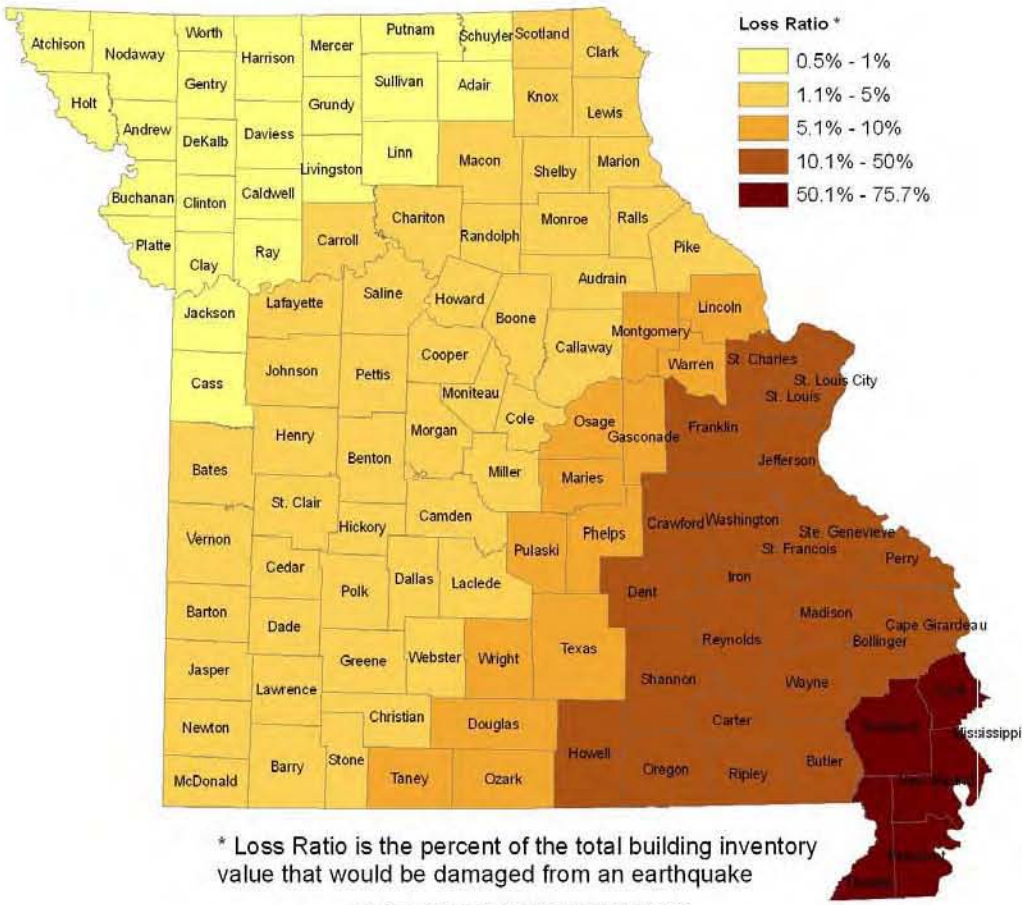


Figure 3.116. HAZUS-MH Earthquake Loss Estimation 2,500 Year Scenario—Loss Ratio



* Loss Ratio is the percent of the total building inventory value that would be damaged from an earthquake

Data Source: HAZUS-MH MR2
Map Compilation: AMEC

Table 3.85 ranks the counties by the total building losses. The loss ratio is included and the top 10 counties ranked by loss ratio are highlighted.

Table 3.85. HAZUS-MH Earthquake Loss Estimation: 2,500 Year Scenario Results Building Impacts by County, Ranked by Highest Building Losses

County	Structural Damage*	Non-Structural Damage*	Loss Ratio**	Contents Damage and Inventory Loss*	Income Loss*'***	Total Building Losses*	Loss Ratio Rank
Saint Louis	2,493,429	8,006,461	13.96	2,669,242	1,876,615	15,045,746	24
Saint Louis City	766,713	2,812,272	15.42	940,042	793,840	5,312,868	23
Saint Charles	436,836	1,378,808	10.27	431,395	277,372	2,524,410	29
Cape Girardeau	349,923	1,274,636	39.90	412,375	256,425	2,293,359	7
Jefferson	392,920	1,268,462	15.63	386,036	216,448	2,263,866	22
Scott	293,380	1,031,239	67.63	335,203	182,029	1,841,851	4
Dunklin	162,880	561,651	58.08	176,159	103,491	1,004,181	5
Stoddard	145,893	516,783	52.32	160,527	80,745	903,949	6
Butler	137,687	456,542	31.54	157,917	131,472	883,618	8
New Madrid	146,721	496,254	75.61	155,669	84,691	883,335	2
Pemiscot	142,192	441,217	72.24	148,900	75,338	807,647	3
Saint Francois	129,327	422,438	19.95	131,543	96,603	779,912	16
Franklin	134,092	403,821	10.36	129,518	85,078	752,509	27
Greene	127,783	325,938	3.31	116,058	161,933	731,711	51
Jackson	120,208	300,527	0.93	96,979	112,162	629,876	93
Mississippi	100,984	344,330	78.53	96,939	49,996	592,249	1
Perry	68,532	222,775	26.76	81,787	44,348	417,442	10
Boone	57,607	151,944	2.65	48,821	66,617	324,988	62
Sainte Genevieve	51,927	169,322	21.42	56,130	32,385	309,764	15
Howell	52,484	150,895	13.76	47,345	45,397	296,121	25
Taney	34,465	93,276	5.85	28,617	68,779	225,137	40
Phelps	39,897	113,851	8.02	34,389	33,826	221,964	32
Cole	39,001	104,201	3.33	35,925	41,885	221,012	50
Wayne	37,554	119,482	25.49	36,466	21,474	214,976	11
Pulaski	39,906	110,042	7.29	29,886	31,246	211,079	33
Bollinger	35,290	110,096	29.20	32,746	17,034	195,166	9
Washington	33,465	101,409	16.76	28,415	20,322	183,611	20
Madison	31,410	99,013	23.60	33,489	19,440	183,352	13
Ripley	30,733	95,394	24.88	33,321	18,643	178,090	12
Camden	28,424	80,161	3.01	25,486	32,775	166,845	55
Crawford	29,498	86,075	10.35	25,951	20,557	162,081	28
Lincoln	30,577	85,678	6.51	25,316	19,001	160,571	39
Clay	31,995	79,102	0.87	24,653	23,658	159,408	95
Texas	24,351	66,259	8.91	21,605	20,736	132,950	31
Warren	24,738	70,004	6.97	21,748	14,576	131,066	35
Dent	23,360	65,149	12.71	21,513	17,140	127,162	26
Iron	21,654	68,344	19.75	20,084	12,482	122,565	17

County	Structural Damage*	Non-Structural Damage*	Loss Ratio**	Contents Damage and Inventory Loss*	Income Loss*,***	Total Building Losses*	Loss Ratio Rank
Christian	23,209	61,529	3.51	19,675	16,088	120,501	47
Jasper	22,677	53,001	1.44	17,514	22,902	116,093	77
Laclede	20,410	49,612	4.64	17,841	18,912	106,775	44
Oregon	18,096	52,191	17.81	15,921	11,639	97,846	19
Webster	22,055	43,687	4.89	15,822	12,250	93,815	43
Reynolds	15,892	50,433	19.40	15,552	10,057	91,933	18
Callaway	17,979	46,506	3.49	13,704	10,886	89,075	49
Stone	16,399	43,174	4.02	12,937	15,972	88,481	46
Carter	14,193	45,031	21.95	14,201	9,726	83,151	14
Gasconade	15,733	42,411	6.93	13,543	10,650	82,337	36
Wright	14,255	36,680	7.04	11,408	10,714	73,058	34
Barry	14,406	33,237	3.19	11,231	12,628	71,503	53
Shannon	11,693	35,679	15.73	10,336	8,926	66,635	21
Audrain	12,696	30,089	3.13	10,851	11,569	65,204	54
Osage	12,259	31,132	5.52	12,759	7,870	64,020	41
Marion	11,137	28,367	2.52	9,527	12,361	61,393	63
Newton	12,039	28,003	1.70	8,567	11,056	59,665	70
Lawrence	11,856	27,617	2.68	9,034	9,532	58,039	60
Cass	12,270	30,579	0.91	8,506	6,285	57,640	94
Buchanan	10,919	26,344	0.72	8,832	10,922	57,018	103
Platte	11,109	29,557	0.83	8,816	7,032	56,515	96
Miller	10,849	27,634	3.51	8,612	7,585	54,680	48
Johnson	9,693	26,768	1.30	8,983	8,047	53,492	81
Pike	10,484	25,366	4.22	8,300	9,102	53,252	45
Ozark	9,902	26,561	9.13	8,034	7,069	51,566	30
Pettis	10,588	23,581	1.61	8,008	9,058	51,234	75
Morgan	10,503	24,578	2.76	7,451	7,837	50,369	58
Montgomery	10,228	24,421	5.09	8,121	6,595	49,365	42
Polk	9,834	22,467	2.82	7,013	7,863	47,177	56
Douglas	8,707	24,073	6.89	6,574	5,698	45,051	37
Maries	7,087	18,239	6.53	5,667	3,675	34,668	38
Randolph	6,510	14,656	1.67	4,963	6,630	32,759	71
Benton	6,141	14,271	2.09	3,926	4,185	28,523	67
Dallas	5,852	14,025	3.28	4,335	4,251	28,463	52
Lafayette	6,225	13,349	1.06	3,952	4,028	27,554	87
Moniteau	5,122	12,583	2.67	4,173	3,228	25,106	61
Saline	5,201	11,532	1.31	3,678	3,937	24,349	80
Cooper	5,099	11,287	2.06	3,544	4,223	24,153	68
McDonald	5,081	11,436	2.26	3,291	3,453	23,261	65
Henry	4,660	10,777	1.32	3,458	3,901	22,796	79
Adair	3,692	8,635	0.98	2,540	4,549	19,416	91
Ralls	3,890	9,406	2.81	2,804	1,960	18,059	57
Vernon	3,925	8,592	1.24	2,651	2,735	17,903	84

County	Structural Damage*	Non-Structural Damage*	Loss Ratio**	Contents Damage and Inventory Loss*	Income Loss*'***	Total Building Losses*	Loss Ratio Rank
Hickory	3,519	8,094	2.73	1,932	1,959	15,503	59
Cedar	3,172	7,167	1.63	2,144	2,595	15,077	73
Monroe	2,907	6,502	2.33	1,895	1,877	13,180	64
Ray	2,914	6,556	0.77	1,892	1,493	12,855	98
Bates	2,626	5,590	1.11	1,666	1,748	11,631	86
Macon	2,413	5,135	1.06	1,480	2,042	11,070	88
Clinton	2,344	5,516	0.71	1,529	1,367	10,756	104
Howard	2,303	5,505	1.78	1,526	1,412	10,746	69
Barton	2,187	4,992	1.33	1,505	1,808	10,492	78
Dade	2,307	5,133	2.20	1,585	1,188	10,213	66
Saint Clair	2,185	4,844	1.62	1,351	1,528	9,908	74
Nodaway	2,020	4,490	0.58	1,444	1,724	9,678	110
Lewis	2,106	4,664	1.60	1,285	1,229	9,284	76
Linn	2,012	4,166	0.96	1,245	1,277	8,700	92
Livingston	1,777	3,915	0.80	1,120	1,577	8,390	97
Chariton	1,943	3,915	1.26	1,232	1,134	8,225	83
Carroll	1,912	3,909	1.05	1,216	1,171	8,208	89
Shelby	1,792	3,781	1.67	1,231	940	7,744	72
Andrew	1,569	3,650	0.60	1,010	838	7,068	109
Clark	1,340	2,867	1.27	820	848	5,875	82
Grundy	1,002	2,179	0.62	610	839	4,631	108
Dekalb	873	1,870	0.65	523	625	3,890	106
Knox	904	1,761	1.17	537	539	3,741	85
Caldwell	865	1,902	0.73	492	400	3,659	102
Atchison	768	1,654	0.74	584	564	3,570	101
Daviess	819	1,710	0.63	548	452	3,528	107
Sullivan	779	1,620	0.75	454	606	3,459	100
Scotland	827	1,544	1.01	479	528	3,378	90
Harrison	749	1,530	0.51	407	519	3,205	114
Holt	663	1,420	0.76	471	450	3,003	99
Gentry	645	1,302	0.55	393	500	2,841	111
Schuyler	504	822	0.70	250	358	1,934	105
Putnam	459	825	0.54	220	281	1,785	112
Mercer	342	694	0.53	178	181	1,394	113
Worth	197	400	0.49	112	116	825	115

Source: HAZUS-MH MR2
Note:
*All $ values are in thousands
**Loss ratio is the sum of structural and nonstructural damage divided by the entire building inventory value within a county
***Total income loss includes relocation loss, capital-related loss, wages loss, and rental income loss

Table 3.86 shows social impact estimates by county for the same event. Table 3.876 provides definitions for casualty severity, displaced households, and short-term shelter needs as used in Table 3.86. Casualties resulting from an earthquake will vary depending on if the earthquake

occurs during the middle of the night, middle of the day, or rush hour. HAZUS-MH provides casualty estimates for three different times of day: 2 a.m., 2 p.m., and 5 p.m. Table 3.86 and the map in Figure 3.117 represent the 2 a.m. timeframe.

Table 3.86. Social Impact Estimates by County from the 2,500 Year Scenario 2 a.m. time of occurrence

County	MMI Zone	Casualty Severity Level 1	2	3	4	Total	Displaced Households	Short-Term Shelter Needs
Adair	VII	12	2	0	0	14	23	7
Andrew	VI	5	1	0	0	6	6	1
Atchison	VI	2	0	0	0	2	3	1
Audrain	VII	35	7	1	1	44	52	13
Barry	VI	50	9	1	2	61	62	16
Barton	VI	7	1	0	0	9	9	2
Bates	VI	8	1	0	0	10	9	2
Benton	VI	18	3	0	0	21	18	5
Bollinger	VIII	216	57	7	14	295	528	134
Boone	VII	161	30	3	6	200	412	113
Buchanan	VI	28	4	0	1	33	51	14
Butler	VIII	772	208	28	54	1,062	2,307	664
Caldwell	VI	3	0	0	0	4	4	1
Callaway	VII	72	14	1	3	90	95	23
Camden	VI	61	12	1	2	76	90	21
Cape Girardeau	VIII	1,715	479	67	129	2,390	5,883	1,517
Carroll	VI	5	1	0	0	6	6	1
Carter	VII	82	21	3	5	111	183	52
Cass	VI	35	6	1	1	43	50	11
Cedar	VI	10	2	0	0	13	11	3
Chariton	VII	5	1	0	0	6	5	1
Christian	VI	96	19	2	4	121	157	37
Clark	VII	4	1	0	0	5	4	1
Clay	VI	70	11	1	2	85	147	33
Clinton	VI	6	1	0	0	8	8	2
Cole	VII	109	22	3	5	138	247	62
Cooper	VI	15	3	0	1	19	19	5
Crawford	VI	136	32	4	8	181	277	72
Dade	VI	8	1	0	0	10	8	2
Dallas	VI	25	4	0	1	31	28	8
Daviess	VI	2	0	0	0	3	2	1
DeKalb	VI	4	1	0	0	4	4	1
Dent	VI	109	26	3	7	145	241	65
Douglas	VI	50	11	1	2	64	82	23
Dunklin	IX	1,258	357	47	90	1,751	4,697	1,391
Franklin	VI	571	138	18	36	763	1,266	287
Gasconade	VI	56	12	1	3	73	102	24
Gentry	VI	2	0	0	0	2	2	0

County	MMI Zone	Casualty Severity Level 1	2	3	4	Total	Displaced Households	Short-Term Shelter Needs
Greene	VI	337	67	8	16	428	769	207
Grundy	VI	3	0	0	0	4	4	1
Harrison	VI	2	0	0	0	3	2	1
Henry	VI	13	2	0	0	16	19	5
Hickory	VI	13	2	0	0	16	10	3
Holt	VI	2	0	0	0	2	2	0
Howard	VII	9	1	0	0	10	10	2
Howell	VI	308	76	10	19	413	677	188
Iron	VII	133	35	5	9	182	307	83
Jackson	VI	267	43	5	9	324	643	175
Jasper	VI	65	11	1	2	79	105	28
Jefferson	VII	1,925	493	67	130	2,615	4,394	972
Johnson	VI	27	4	0	1	32	45	12
Knox	VII	2	0	0	0	3	3	1
Laclede	VI	72	14	1	3	89	111	30
Lafayette	VI	16	2	0	0	19	21	5
Lawrence	VI	42	7	1	1	52	54	14
Lewis	VIII	8	1	0	0	9	9	2
Lincoln	VIII	139	29	3	6	178	211	48
Linn	VI	6	1	0	0	7	7	2
Livingston	VI	5	1	0	0	6	8	2
Macon	VII	8	1	0	0	10	11	3
Madison	VII	167	44	6	11	228	423	118
Maries	VI	30	6	1	1	39	50	12
Marion	VIII	30	6	1	1	38	62	17
McDonald	V	24	4	0	1	28	23	6
Mercer	VI	1	0	0	0	1	1	0
Miller	VI	41	8	1	2	51	60	15
Mississippi	X	774	223	27	52	1,076	3,440	1,055
Moniteau	VI	18	3	0	1	22	24	6
Monroe	VII	10	2	0	0	13	11	2
Montgomery	VII	31	6	1	1	40	46	11
Morgan	VI	25	4	0	1	30	28	7
New Madrid	X	1,053	301	37	70	1,461	4,448	1,277
Newton	VI	43	7	1	1	52	47	12
Nodaway	VI	6	1	0	0	7	9	2
Oregon	VII	114	29	4	7	154	262	75
Osage	VII	33	7	1	2	43	52	12
Ozark	VI	51	11	1	2	66	81	22
Pemiscot	X	993	284	36	68	1,381	3,997	1,281
Perry	VIII	288	78	11	21	397	724	175
Pettis	VI	27	4	0	1	33	43	11
Phelps	VI	174	39	5	10	228	380	106
Pike	VIII	36	7	1	2	46	49	12
Platte	VI	28	4	0	1	33	67	14

County	MMI Zone	Casualty Severity Level 1	2	3	4	Total	Displaced Households	Short-Term Shelter Needs
Polk	VI	35	6	1	1	43	40	10
Pulaski	VI	152	34	4	9	199	234	58
Putnam	VII	1	0	0	0	2	2	0
Ralls	VIII	13	2	0	0	16	14	3
Randolph	VII	18	3	0	1	22	26	7
Ray	VI	9	1	0	0	11	12	3
Reynolds	VII	84	22	3	6	114	185	48
Ripley	VII	200	52	6	12	270	472	141
Saline	VI	14	2	0	0	17	18	5
Schuyler	VII	1	0	0	0	2	2	0
Scotland	VII	2	0	0	0	3	2	1
Scott	IX	1,868	533	68	129	2,599	7,066	1,943
Shannon	VI	87	22	3	5	117	184	54
Shelby	VII	5	1	0	0	6	6	1
St. Charles	VII	1,720	428	60	117	2,325	4,079	843
St. Clair	VI	7	1	0	0	9	8	2
St. Francois	VII	681	179	25	48	931	1,725	456
St. Louis	VIII	8,821	2,321	340	667	12,149	14,831	4,852
St. Louis City	VIII	3,314	882	130	256	4,581	26,346	6,161
Ste. Genevieve	VII	233	61	8	16	319	525	122
Stoddard	IX	1,019	288	38	73	1,417	3,598	965
Stone	VI	62	12	1	2	77	85	21
Sullivan	VI	2	0	0	0	3	3	1
Taney	VI	142	29	3	6	181	232	59
Texas	VI	112	25	3	6	145	215	60
Vernon	VI	11	2	0	0	14	15	4
Warren	VII	92	20	2	5	119	159	37
Washington	VII	241	59	7	14	321	476	132
Wayne	VII	211	54	7	12	284	508	145
Webster	VI	68	14	2	3	86	98	25
Worth	VI	1	0	0	0	1	1	0
Wright	VI	64	14	2	3	83	114	33

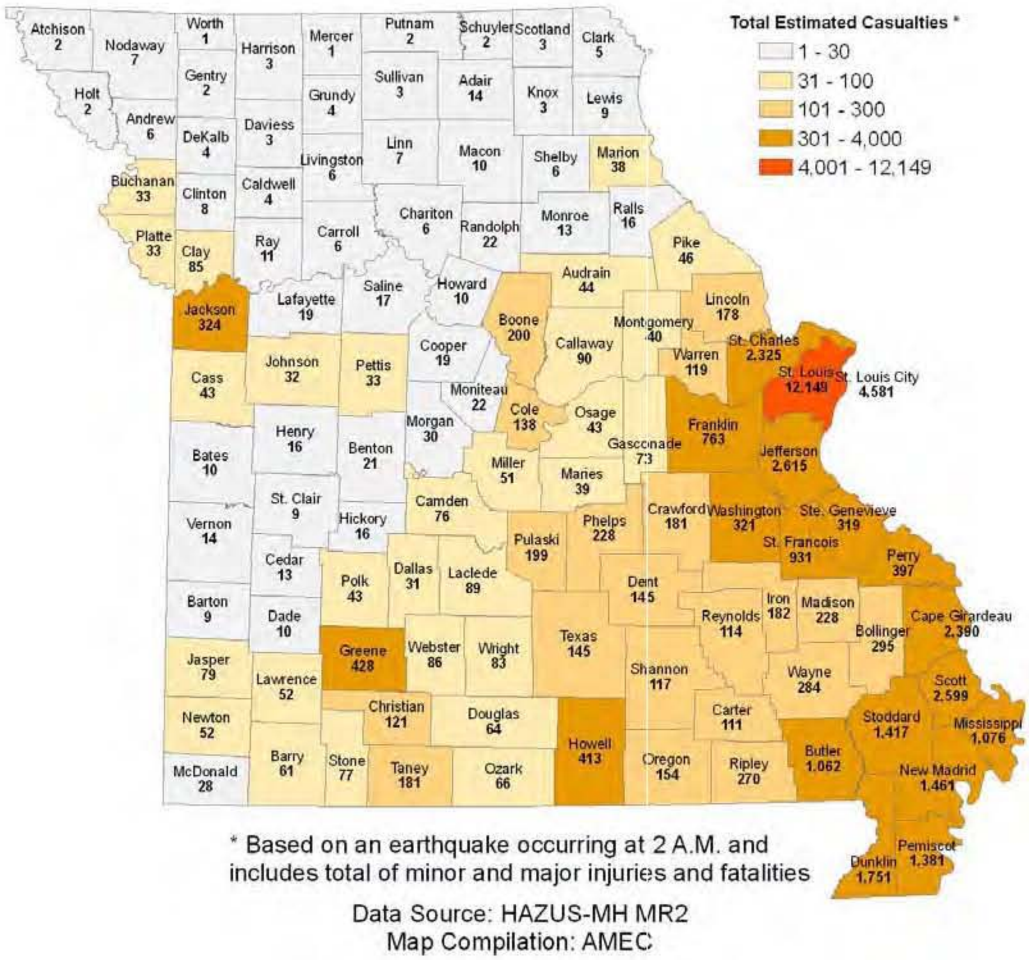
Source: HAZUS-MH MR2

Table 3.87. Casualty Severity, Displaced Households, and Short-Term Shelter Needs

Casualty Severity 1	Injuries requiring basic medical aid that could be administered by paraprofessionals. These types of injuries would require bandages or observation. Examples include a sprain, a severe cut requiring stitches, a minor burn (first degree or second degree on a small part of the body), or a bump on the head without loss of consciousness. Injuries of lesser severity that could be self-treated are not estimated by HAZUS-MH.
Casualty Severity 2	Injuries requiring a greater degree of medical care and use of medical technology, such as x-rays or surgery, but not expected to progress to a life threatening status. Examples include third- or second-degree burns over large parts of the body, a bump on the head that causes loss of consciousness, fractured bone, dehydration, or exposure.
Casualty Severity 3	Injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. Examples include uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.
Casualty Severity 4	Instantaneously killed or mortally injured.
Displaced Households	People evacuating their residence due merely to physical damage to the building (there may be others who need to evacuate for sole reasons of utility service disruption, etc.)
	Results taking into account the functionality of a residence depending on its degree of physical damage.
Short-Term Shelter Needs	People, among the displaced, in need of shelter.
	Results taking into account the influence on choice for shelter based on income level, age group, ethnicity, and ownership.

Source: HAZUS-MH MR2

Figure 3.117. HAZUS-MH Earthquake Loss Estimation 2,500 Year Scenario—Casualties



3.4 Assessing Vulnerability and Estimating Potential Losses of State Facilities

Requirements §201.4(c)(2)(ii) and §201.4(c)(2)(iii):	[The state risk assessment shall include an overview and analysis of the state's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in] the state risk assessment. State owned critical or operated facilities located in the identified hazard areas shall also be addressed. [The State risk assessment shall include an] overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

As Missouri remains vulnerable to natural hazards, state-owned facilities are at risk to incur damage from hazard events and the state's resources, both monetary and fixed assets, depend heavily upon these facilities and their continuity. This section assesses vulnerability and potential losses to state-owned facilities from riverine flooding, tornadoes, and earthquakes, which are the priority hazards. Losses to other hazards may be estimated in future updates to this plan as existing data permits.

Due to homeland security requirements, critical facilities were not analyzed in this risk assessment but are included in the state's terrorism plan. Efforts were made to obtain critical facilities data during the 2007 update to this plan, but vulnerability to hazards could not be determined due to the sensitive nature of this information and the fact that the data has not been geolocated. However, certain state facilities were assessed for potential vulnerability to flooding, tornado, and earthquake hazards. These facilities may not be considered as "critical" as the facilities identified as such in other plans, but they are very important to SEMA in terms of reducing losses to state property. Not all of the state's facilities have been geocoded. Therefore, only those that have been georeferenced as of 2004 are included in this analysis. Table 3.88 includes the state agencies that were included in this analysis, their acronyms, and the number of the state facilities and replacement value of facilities by agency. Note that there was little change to this section in 2007, due to a continuing data limitation. The Missouri Office of Administration is in the process of finalizing and geolocating its state facility inventory, which was a work in progress in 2007. Budget limitations have impeded the ability to complete this task between 2004 and 2007. The database is expected to be finished in 2008.

As of 2007, the Missouri Office of Administration leases 408 structures. There is no additional data to support quantifying risk and loss to these structures.

In the 2007 update, an analysis of flood and earthquake risk to state-owned infrastructure was completed using best available data. The only GIS-based data available for this analysis was the data from the National Inventory of Bridges, which is included with HAZUS-MH. Flood risk and loss to state bridges are quantified in the section that follows. Additional infrastructure data in HAZUS-MH does not differentiate between public or privately owned. Total infrastructure losses to earthquake are included in Appendix F HAZUS-MH Earthquake Results 2,500 Year Scenario Global Summary Report.

Table 3.88. State Agency Acronyms and Dollar Exposure of State Facilities by Agency

Acronym	State Agency/Departments	# of Facilities	Usage	Replacement Value
AG	Missouri Attorney General's Offices	2	General Office	$34,945,067
DHS	Health and Senior Services	1	Main Office	$4,800,509
DMH	Mental Health	22	Main Office/ Clinics	$738,018,325
DOC	Corrections	15*	Main Office/ Prisons	$1,066,423,119*
DOT	Transportation	9	Main Office/District Offices	$24,989,712
DPS	Public Safety—Highway Patrol	13	Headquarters/ Troops	$41,488,402
GOV	Governor's Office	2	State Offices	$702,265,900
MULT	Multiple	1	State Offices	$93,861,820
STO	State Treasurer's Office	1	Main Office	$27,187,858
Totals		66		$2,690,645,907

Note:
*Updated in 2007

Hazards not analyzed in detail for dollar exposure because they are not likely to incur damage include dam failure, drought (no state facilities threatened), hazardous materials, heat wave, land subsidence/sinkholes, mass transportation accidents, nuclear power plants, public health emergencies, severe winter weather, special events, and utilities. Table 3.89 in Section 3.4.2 Tornadoes shows state structures vulnerable to tornadoes. Hazards such as attack, civil disorder, fires, and terrorism may also occur anywhere in the state and thus are similar to tornadoes in regard to their risk and vulnerability.

3.4.1 Riverine Flooding

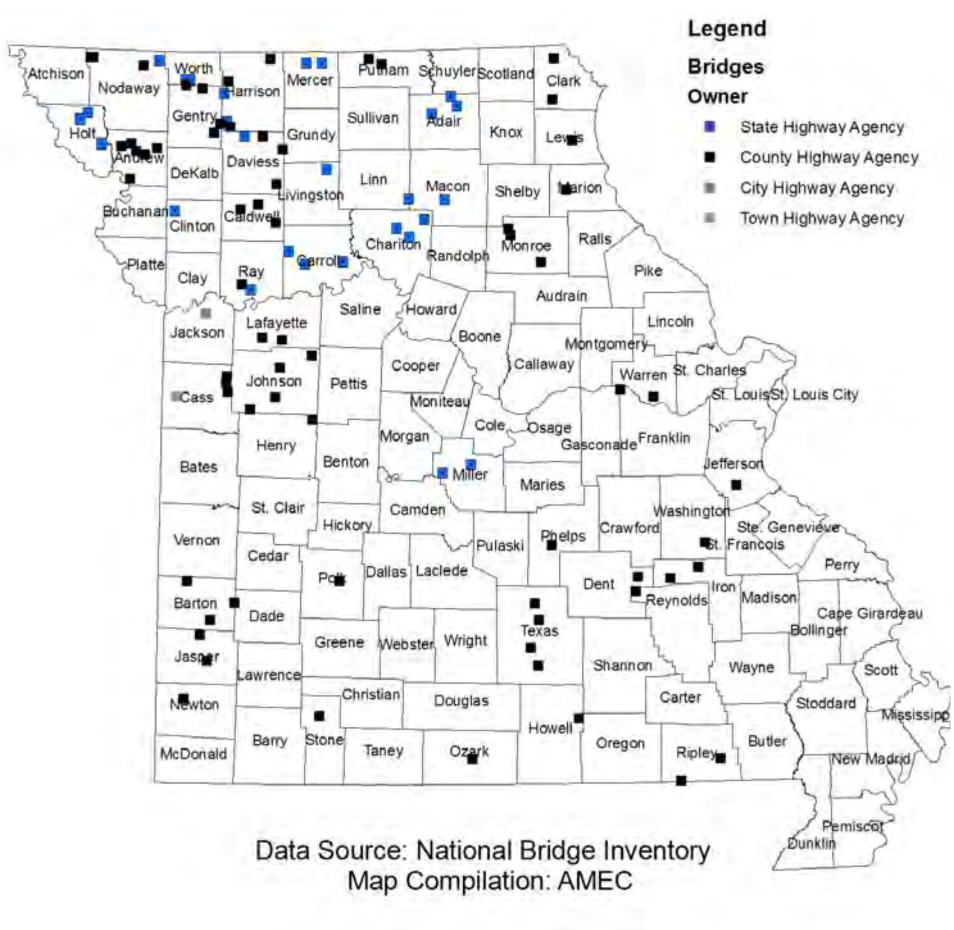
Note: For background information about riverine flooding, see the profile in Section 3.2.7.

Although flooding is a major hazard in Missouri, current available data suggests that most state high-priority facilities are not susceptible to flood damage, with the notable exception of the current State Health Lab. To remedy that problem, a new State Health Lab facility is being built in an area that is not in the floodplain.

Analysis of Scour Critical Bridges

Included with HAZUS-MH is a database of bridges called the National Bridge Inventory, which was developed by the Federal Highway Administration. One of the database items includes a "scour index" that is used to quantify the vulnerability of bridges to scour during a flood. Bridges with a scour index between 1 and 3 are considered "scour critical," or a bridge with a foundation element determined to be unstable for the observed or evaluated scour condition. A query of the database was performed that identified the scour critical bridges. Out of 21,765 bridges in Missouri, 102 met these criteria. Of the 102, 33 are owned by the Missouri Department of Transportation (MODOT). Replacement costs for these MODOT-owned, at-risk bridges are estimated to be $23 million. The remaining are maintained by city (1), county (67), or town (1) highway agencies. These are bridges that could benefit from mitigation projects or be thoroughly inspected following a flood event. Locations of these bridges are indicated on Figure 3.118.

Figure 3.118. Flood Scour Critical Bridges



3.4.2 Tornadoes

Note: For background information about tornadoes, see the profile in Section 3.2.9.

Historical evidence shows that most of the state is vulnerable to tornado activity. Because it cannot be predicted where a tornado may touch down, all buildings and facilities are considered to be exposed to this hazard and could potentially be impacted. Table 3.89 lists the number of state high-priority facilities by agency and county that might suffer at least slight damage due to tornadic activity or severe winds.

Table 3.89. Distribution of State Facilities Vulnerable to Tornado by County

Acronym	County	Total
AG	Cole	1
AG	St. Louis	1
DHS	Cole	1
DMH	Adair	1
DMH	Butler	1
DMH	Callaway	1
DMH	Cape Girardeau	1
DMH	Cole	1
DMH	Gentry	1
DMH	Greene	1
DMH	Jackson	2
DMH	Jasper	1
DMH	Lafayette	1
DMH	Marion	1
DMH	Phelps	1
DMH	St. Francois	1
DMH	St. Louis	6
DMH	Saline	1
DMH	Scott	1
DMH	Vernon	1
DOC	Audrain	1
DOC	Buchanan	1
DOC	Cole	3
DOC	Cooper	1
DOC	DeKalb	2
DOC	Livingston	1

Acronym	County	Total
DOC	Pike	1
DOC	Randolph	1
DOC	St. Francois	1
DOC	St. Louis	1
DOC	Washington	1
DOC	Webster	1
DOT	Buchanan	1
DOT	Cole	1
DOT	Greene	1
DOT	Howell	1
DOT	Jackson	1
DOT	Jasper	1
DOT	Marion	1
DOT	St. Louis	1
DOT	Scott	1
DPS	Buchanan	1
DPS	Butler	1
DPS	Cole	7
DPS	Greene	1
DPS	Jackson	1
DPS	Macon	1
DPS	St. Louis	1
GOV	Cole	2
MULT	Cole	1
STO	Jackson	1
Total		**67**

Table 3.90 shows the potential qualitative risk to tornado by county. The numbers of state facilities are depicted as having a Moderate, High, or Very High risk to tornadoes by county. For definitions of the risk rating, refer to Section 3.3.4 Assessing Vulnerability by Jurisdiction.

Table 3.90. Potential Qualitative Risk Due to Tornado by County

Acronym	County	Moderate	High	Very High	Total
AG	Cole	0	1	0	1
AG	St. Louis	0	0	1	1
DHS	Cole	0	1	0	1
DMH	Adair	0	1	0	1
DMH	Butler	0	1	0	1
DMH	Callaway	0	0	1	1
DMH	Cape Girardeau	0	1	0	1
DMH	Cole	0	1	0	1
DMH	Gentry	0	1	0	1
DMH	Greene	0	0	1	1
DMH	Jackson	0	0	2	2
DMH	Jasper	0	0	1	1
DMH	Lafayette	0	1	0	1
DMH	Marion	0	1	0	1
DMH	Phelps	0	0	1	1
DMH	Saline	0	1	0	1
DMH	Scott	0	0	1	1
DMH	St. Francois	0	0	1	1
DMH	St. Louis	0	0	6	6
DMH	Vernon	0	1	0	1
DOC	Audrain	0	1	0	1
DOC	Buchanan	0	1	0	1
DOC	Cole	0	3	0	3
DOC	Cooper	0	1	0	1
DOC	DeKalb	0	2	0	2
DOC	Livingston	1	0	0	1
DOC	Pike	0	1	0	1
DOC	Randolph	0	1	0	1
DOC	St. Francois	0	0	1	1
DOC	St. Louis	0	0	1	1
DOC	Washington	0	1	0	1
DOC	Webster	0	0	1	1
DOT	Buchanan	0	1	0	1
DOT	Cole	0	1	0	1
DOT	Greene	0	0	1	1
DOT	Howell	0	0	1	1
DOT	Jackson	0	0	1	1
DOT	Jasper	0	0	1	1
DOT	Marion	0	1	0	1

Acronym	County	Moderate	High	Very High	Total
DOT	Scott	0	0	1	1
DOT	St. Louis	0	0	1	1
DPS	Buchanan	0	1	0	1
DPS	Butler	0	1	0	1
DPS	Cole	0	7	0	7
DPS	Greene	0	0	1	1
DPS	Jackson	0	0	1	1
DPS	Macon	1	0	0	1
DPS	St. Louis	0	0	1	1
GOV	Cole	0	1	0	1
MULT	Cole	0	1	0	1
STO	Jackson	0	0	1	1
Total		**2**	**36**	**28**	**66**

3.4.3 Earthquakes

Note: For background information about earthquakes, see the profile in Section 3.2.3.

Table 3.91 shows the number of state high-priority facilities that would be susceptible to suffering at least slight damage from an earthquake with a 100-year and a 500-year recurrence interval based on using HAZUS-MH probabilistic modeling. Table 3.92 shows the estimated losses to state high-priority facilities due to an earthquake.

Table 3.91. Distribution of State Facilities Vulnerable to Earthquake

Acronym	County	Number of Facilities 100-Year Earthquake	Number of Facilities 500-Year Earthquake
AG	Cole	0	1
AG	St. Louis	1	1
DHS	Cole	0	1
DMH	Adair	0	1
DMH	Butler	1	1
DMH	Callaway	0	1
DMH	Cape Girardeau	1	1
DMH	Cole	0	1
DMH	Gentry	0	1
DMH	Greene	0	1
DMH	Jackson	0	1
DMH	Jasper	0	1
DMH	Lafayette	0	1
DMH	Marion	0	1
DMH	Phelps	0	1
DMH	St. Francois	1	1
DMH	St. Louis	6	1
DMH	Saline	0	1

Acronym	County	Number of Facilities 100-Year Earthquake	Number of Facilities 500-Year Earthquake
DMH	Scott	1	1
DMH	Vernon	0	1
DOC	Audrain	0	1
DOC	Buchanan	0	1
DOC	Cole	0	1
DOC	Cooper	0	1
DOC	DeKalb	0	1
DOC	Livingston	0	1
DOC	Pike	0	1
DOC	Randolph	0	1
DOC	St. Francois	0	1
DOC	St. Louis	1	1
DOC	Washington	1	1
DOC	Webster	0	1
DOT	Buchanan	0	1
DOT	Cole	0	1
DOT	Greene	0	1
DOT	Howell	0	1
DOT	Jackson	0	1
DOT	Jasper	0	1
DOT	Marion	0	1
DOT	St. Louis	1	1
DOT	Scott	1	1
DPS	Buchanan	0	1
DPS	Butler	1	1
DPS	Cole	0	0
DPS	Greene	0	1
DPS	Jackson	0	1
DPS	Macon	0	1
DPS	St. Louis	1	1
GOV	Cole	0	1
MULT	Cole	0	1
STO	Jackson	0	1
Total		**17**	**50**

Table 3.92. Estimated Loss to State Facilities Due to Earthquake

Acronym	County	Number of Facilities	Estimated Loss 100-year Earthquake	Estimated Loss 500-year Earthquake
AG	Cole	1	0	$85,017
AG	St. Louis	1	$264,434	$2,379,902
DHS	Cole	1	0	$48,005
DMH	Adair	1	0	$2,427,907
DMH	Butler	1	$50,744	$932,639
DMH	Callaway	1	0	$1,305,094
DMH	Cape Girardeau	1	$315,178	$7,178,565
DMH	Cole	1	0	$81,001
DMH	Gentry	1	0	$21,437
DMH	Greene	1	0	$22,806
DMH	Jackson	2	0	$655,881
DMH	Jasper	1	0	$678,687
DMH	Lafayette	1	0	$263,209
DMH	Marion	1	0	$24,519
DMH	Phelps	1	0	$287,728
DMH	St. Francois	1	$573,922	$5,124,291
DMH	St. Louis	6	$2,767,621	$10,514,295
DMH	Saline	1	0	$736,590
DMH	Scott	1	$118,100	$1,817,483
DMH	Vernon	1	0	$665,113
DOC	Audrain	1	0	$501,989
DOC	Buchanan	1	0	$594,123
DOC	Cole	3	0	$2,454,792
DOC	Cooper	1	0	$929,783
DOC	DeKalb	2	0	$1,180,956
DOC	Livingston	1	0	$154,428
DOC	Pike	1	0	$877,175
DOC	Randolph	1	0	$963,964
DOC	St. Francois	1	$1,474,106	$11,166,867
DOC	St. Louis	1	$289,194	$1,511,388
DOC	Washington	1	$595,911	$2,856,097
DOC	Webster	1	0	$194,789
DOT	Buchanan	1	0	$13,163
DOT	Cole	1	0	$100,099
DOT	Greene	1	0	$26,098
DOT	Howell	1	0	$13,344
DOT	Jackson	1	0	$26,098
DOT	Jasper	1	0	$21,801
DOT	Marion	1	0	$21,332
DOT	St. Louis	1	$23,696	$118,481
DOT	Scott	1	$39,488	$539,663
DPS	Buchanan	1	0	$20,652
DPS	Butler	1	$16,952	$135,619

Acronym	County	Number of Facilities	Estimated Loss 100-year Earthquake	Estimated Loss 500-year Earthquake
DPS	Cole	7	0	$263,570
DPS	Greene	1	0	$20,150
DPS	Jackson	1	0	$23,108
DPS	Macon	1	0	$14,808
DPS	St. Louis	1	$25,644	$51,288
GOV	Cole	1	0	$66,096
MULT	Cole	1	0	$938,618
STO	Jackson	1	0	$271,879
Total		**66**	**$5,924,636**	**$61,322,387**

3.5 Summary and Conclusions

The results of this analysis are useful in many ways, including, but not limited to the following:

- Based on the updated risk assessment, the state's high risk to floods is now quantified, and the relative risk by county known. Certain counties in southeastern Missouri are at risk to multiple high-priority hazards, including floods, tornadoes, and earthquakes.
- Severe winter weather is a high concern hazard based on local mitigation plans.
- Earthquakes continue to be high consequence but low probability events that have the potential to impact Missouri on a regional scale. Improvements in available data are helping to refine the lost estimations.
- Knowledge about risk associated with natural hazards in Missouri is improving through better understanding of the complexities and dynamics of risk, how levels of risk can be measured and compared, and the myriad factors that influence risk. An understanding of these relationships is critical in balanced and informed decisions on managing risk.
- The risk assessment provides a baseline for policy development and comparison of mitigation alternatives. The data used for this analysis present a current picture of risk in Missouri. Updating this risk "snapshot" with future data will enable comparison of the changes in risk with time. Baselines of this type can support the objective analysis of policy and program options for risk reduction in the state. Missouri's population growth and development trends are continuing to increase, thus the current risk will only increase if risk reduction measures are not planned and implemented.
- The risk assessment provides a comparison of risk among the hazards addressed. The ability to quantify the risk to the priority hazards relative to one another helps in a balanced, multihazard approach to risk management at each level of governing authority. This analysis provides a systematic framework to compare and prioritize the very disparate hazards that are present in Missouri and provides the necessary information for the HMPT to craft a mitigation strategy to focus resources based on priority hazards and the most threatened populations and property.

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4.0 Comprehensive State Hazard Mitigation Program

It is essential that state and local mitigation policy be directed to minimize the risk of future devastation and the corresponding impact on the residents and property of the State of Missouri. This can only be accomplished by establishing workable goals and objectives that integrate the efforts of state and local governments into one cohesive mitigation strategy and that also take full advantage of public-private partnerships.

Development of a sound mitigation strategy provides a focus that helps state and local governments identify priorities and channel their limited resources toward critical mitigation projects. This process helps government at all levels make the most effective use of available resources.

The state will continue to enhance its ability to meet its goals and objectives by taking maximum advantage of the mitigation resources available, both present and future, to reduce the impact of natural and manmade disasters on the residents and infrastructure of Missouri. The state will also continue to vigorously pursue methods to augment existing state and local programs by exploring and taking advantage of other opportunities, such as public-private partnerships. The state will continue to provide education and training on the benefits of a comprehensive statewide hazard mitigation program for state agencies, local governments, private enterprises, and the residents of Missouri.

The results of the planning process, which include the risk assessment, capability assessment, goal setting, and identification of mitigation measures, and the hard work of the Hazard Mitigation Planning Team (HMPT) led to the action plan that follows. The process helped the HMPT clearly comprehend and identify the overall mitigation strategy that guides the implementation of the action plan and the day-to-day mitigation efforts of the state. Taking all of the above into consideration, the HMPT developed this comprehensive mitigation strategy:

- **Implement** the action plan recommendations of this plan.
- **Use** existing regulations, policies, programs, procedures, and plans already in existence.
- **Monitor** multiobjective management opportunities, share and package funding opportunities, and garner broader constituent support.
- **Communicate** the hazard information collected and analyzed through this planning process so that Missouri's local governments and residents better understand what can happen where, and what they themselves can do to mitigate impacts. In doing so, also publicize the successes that have been achieved through the state's ongoing efforts.

This chapter focuses on the state's hazard mitigation program. It is divided into five parts:

- Hazard Mitigation Goals and Objectives
- State Capability Assessment
- Local Capability Assessment
- Mitigation Actions
- Funding Sources

4.1 Hazard Mitigation Goals and Objectives

Requirement §201.4(c)(3)(ii):	[The state mitigation strategy shall include a] description of state goals to guide the selection of activities to mitigate and reduce potential losses.
Update §201.4(d):	[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts and changes in priorities.

The purpose of this section is to describe the goals and objectives of the state mitigation program. In order to be effective, these goals and objectives must be achievable and they must complement both state and local mitigation strategies. They also play a role in the review and prioritization of proposed mitigation projects, which must also complement the state's overall mitigation strategy. Before adopting them, the state evaluated the goals and objectives, and especially the actions, using the STAPLEE (social, technical, administrative, political, legal, economic, and environmental) criteria.

It is important that the results of these mitigation efforts are evident to state and local governments, public-private partnerships, and the general public. By establishing achievable goals and objectives, the groups involved in the process can see that their efforts are making a difference and that success in other mitigation efforts is also possible.

The state reviews these goals and objectives as part of the regular plan update process and more frequently as needed to reflect current situations in Missouri. The process used to identify, review, and update the goals and objectives during the 2007 update is described later in this section.

Section 4.1.1 provides the primary goals and objectives for the state's hazard mitigation program in prioritized order. The goals and objectives reflect the mature nature of SEMA's established statewide hazard mitigation program and have evolved over several years of state mitigation planning efforts. SEMA encourages its partners to consider these mitigation goals when developing local mitigation plans and other plans.

4.1.1 State of Missouri Mitigation Goals and Objectives

Goal 1: Implement mitigation actions that improve the protection of human life, health, and safety from the adverse effects of disasters

Objective 1: Maintain a robust mitigation program that addresses ways to mitigate the loss of life from disaster events. (This includes supporting the development and funding of sensible mitigation projects to reduce future flooding, eliminate repetitive flood losses, improve safety and reduce losses during severe weather events, mitigate losses due to earthquakes, minimize losses due to terrorism, and reduce risk and losses due to drought, high heat, and fire.)

Objective 2: Strengthen cooperation with SEMA's mitigation partners and help educate them about mitigation.

Objective 3: Support the development of sensible enabling legislation, programs, and capabilities of federal, state, and local governments and public-private partnerships engaged in mitigation activities.

Objective 4: Increase public awareness of disaster risks and effective mitigation measures that protect life.

Objective 5: Maintain a high level of mitigation proficiency among SEMA staff.

Goal 2: Implement mitigation actions that improve the protection of continuity of government and essential services safety from the adverse effects of disasters

Objective 1: Support the development of sensible mitigation projects to protect key and essential facilities and services.

Objective 2: Continue to educate federal, state, and local public officials; educational institutions; private associations; and private business entities that provide essential services about hazards and how mitigation can reduce losses and help maintain continuity.

Objective 3: Educate state and local officials concerning the need to use sensible mitigation techniques for new facility construction.

Objective 4: Encourage maximum participation in maintaining effective state and local mitigation plans, disaster plans, and business continuity plans.

Objective 5: Encourage federal, state, and local officials; educational institutions; private associations; and private business entities that provide essential services to incorporate mitigation into other plans.

Goal 3: Implement mitigation actions that improve the protection of public and private property from the adverse effects of disasters

Objective 1: Maintain a robust mitigation program that addresses ways to mitigate the loss of property from disaster events. (This includes supporting the development and funding of sensible mitigation projects to reduce future flooding, eliminate repetitive flood losses, improve safety and reduce losses during severe weather events, mitigate losses due to earthquake, minimize losses due to terrorism, and reduce risk and losses due to drought, high heat, and fire.)

Objective 2: Strengthen cooperation with SEMA's mitigation partners and help educate them about mitigating the loss of property.

Objective 3: Support organizations that work to help mitigate the adverse effects of disasters.

Objective 4: Increase public awareness of disaster risks and effective mitigation measures that protect property.

Objective 5: Support the National Flood Insurance Program, Community Rating System, earthquake insurance, and other programs that serve to lessen the adverse impact of disaster property losses.

Goal 4: Implement mitigation actions that improve the protection of community tranquility from the adverse effects of disasters

Objective 1: Develop, implement, and complete mitigation projects as expeditiously, effectively, efficiently, and unobtrusively as possible.

Objective 2: Consider sustainability issues (ecologically sound, economically viable, socially just, and humane) when developing or reviewing mitigation projects and plans.

Objective 3: Lead and support the work of mitigation partners to educate the general public about how mitigation can help protect communities and promote community tranquility.

Objective 4: Develop and provide periodic reports and success stories to federal, state, and local public officials, educational institutions, private associations, private business entities, and the public on the progress of hazard mitigation activities.

Objective 5: Encourage citizens and citizen organizations to support and use mitigation in plans, projects, and public outreach to increase a sense of community security and safety.

4.1.2 Process for Identifying, Reviewing, and Updating State Goals and Objectives

Missouri's Hazard Mitigation Planning Team (HMPT) developed these goals and objectives to guide the state mitigation program and the selection of actions to mitigate potential losses from hazard events. The goals and objectives represent a long-term vision for hazard reduction and

enhancement of mitigation capabilities and have evolved over years of mitigation planning in Missouri. In developing the 2004 plan, the HMPT evaluated and prioritized the goals, objectives, and mitigation actions using STAPLEE, which is a set of evaluative criteria based on the following characteristics:

- **S**ocial
- **T**echnical
- **A**dministrative
- **P**olitical
- **L**egal
- **E**conomic
- **E**nvironmental

As part of the 2007 plan update, the goals and objectives from the 2004 plan were reviewed to determine if they still address current and anticipated future conditions. This was accomplished during an HMPT meeting and during focused meetings with SEMA mitigation staff. The HMPT evaluated the goals and objectives based on the process outlined in Section 6.2.2 Progress Review for Mitigation Goals and Objectives. In addition to that process, the review was based on:

- The updated statewide risk assessment, which includes changes in growth and development, recent disasters, and analysis of local risk assessments;
- Assessment of changes and challenges in state and local capabilities since the 2004 plan;
- Analysis of the similarities and differences of the state mitigation plan goals with local mitigation plan goals and objectives; and
- Identification of achieved mitigation objectives from the 2004 plan.

The key issues identified in the statewide risk assessment and the analysis of local risk assessments can be found in Chapter 3 Risk Assessment. Information on the changes in state and local mitigation capabilities is summarized in Sections 4.2 State Capability Assessment and 4.3 Local Capability Assessment. The following section describes how the local mitigation plan goals and objectives were reviewed and considered during the 2007 update. Section 4.4 Mitigation Actions includes detailed and updated mitigation measures designed to meet the designated goals and objectives and progress on these objectives is evaluated in Sections 4.4 and Section 7.5 Effective Use of Available Mitigation Funding.

The HMPT concluded that the goals and objectives from the 2004 plan remain valid and continue to guide the state’s mitigation strategy. Life safety remains the top priority.

4.1.3 Review of Local Goals and Objectives

SEMA analyzed the mitigation strategies of FEMA-approved local hazard mitigation plans to assess their consistency with state goals and objectives. To be effective, the state goals and

objectives must be achievable and also complement the mitigation strategies of local plans. SEMA calculated the percentage of local plans (out of a total of 97 plans) that have a similar goal to each of the four goals in the 2004 Missouri State Hazard Mitigation Plan.

The results in Table 4.1 show that most local plans have similar goals to State Goal 1 to improve protection of life, health, and safety (90 percent) and State Goal 3 to improve protection of public and private property (85 percent). More than half of local plans have a goal similar to State Goal 2 to improve protection of continuity of government and essential services from the adverse effects of disasters. SEMA also assessed local goals that address a specific hazard and found that 26 percent of local plans have a goal related to reducing the impacts of flooding.

Table 4.1. Percentage of Local Plans with Similar Goals to State Plan

Missouri State Hazard Mitigation Plan Goals	Local Plans with Similar Goal
Goal 1: Improve Protection of Life, Health, and Safety	90%
Goal 2: Improve Protection of Continuity of Government and Essential Services	57%
Goal 3: Improve Protection of Public and Private Property	85%
Goal 4: Improve Protection of Community Tranquility	92%

SEMA also analyzed the local goals that differed from state goals. Table 4.2 lists common general goals among the local plans and the percent of plans that contained a similar goal. The third column in the table lists the percentage of local plans that had a similar objective. Because the local plans were developed by Missouri's Regional Planning Commissions, many plans in the same region had very similar goals and objectives. The HMPT concluded that the additional goals and objectives identified by the local plans, while not worded exactly the same, tended to align with State Goal 4 to improve protection of community tranquility or were similar to the state plan's objectives. While many of the local plans identified promoting public education and awareness as a goal, the HMPT views this as an objective, which is currently listed under each of this plan's goals.

Table 4.2. Other Common Goals and Objectives in Local Plans

Common Goals in Local Plans	Local Plans with Similar Goal	Local Plans with Similar Objective
Promote Public Information, Education, and Awareness about Hazards and Risk	44%	30%
Improve Structures and Infrastructure to Reduce Hazard Impacts	41%	32%
Manage Growth and Development in Hazard Areas	35%	25%
Establish Long-Term Risk Reduction Priorities	20%	0%
Strengthen Communication, Cooperation, and Partnerships	21%	23%
Maintain Local Economy	20%	3%
Secure Resources for Investment in Hazard Mitigation	20%	2%
Reduce Risk to Most Vulnerable Populations	18%	4%
Protect and Restore Natural Systems	14%	24%
Improve Warning and Emergency Systems	14%	79%
Design Policies to Limit Hazard Impacts	8%	2%

4.2 State Capability Assessment

Requirement §201.4(c)(3)(ii):	[The state mitigation strategy shall include a] discussion of the state's pre-and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including: An evaluation of state laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas; [and] A discussion of state funding capabilities for hazard mitigation projects.

This section discusses Missouri's existing capabilities, including state agencies, programs, outreach and partnerships, and plans and policies, for mitigating hazards, both pre- and postdisaster. State capabilities related to development in hazard-prone areas and funding hazard mitigation projects are also discussed. During the 2007 plan update, the Hazard Mitigation Planning Team (HMPT) evaluated capabilities by identifying the changes in capabilities since the 2004 Missouri State Hazard Mitigation Plan and assessing the challenges and opportunities for improving capabilities.

4.2.1 State Agencies

The roles and responsibilities of the Missouri State Emergency Management Agency (SEMA) and the other agencies involved in statewide emergency preparedness, response, recovery, and mitigation activities are outlined below. While each state agency administers its own programs, SEMA is the manager and provides leadership for the overall state mitigation strategy. The agencies work together to ensure that the various mitigation programs complement each other and work toward achieving the state's overall strategy. One way that agencies work together is

by participating on the HMPT, the group responsible for the preparation and review of this plan and for state review of all mitigation initiatives.

State Emergency Management Agency

The State Emergency Management Agency (SEMA) is the state agency responsible for coordinating statewide emergency preparedness, response, recovery, and mitigation activities among federal, state, and local agencies. The SEMA director is the state coordinating officer during disasters and also serves as the governor's authorized representative and liaison to FEMA; this position designates the federal coordinating officer. During disaster operations, all departments of state government are expected to cooperate fully with requests for assistance from the SEMA director. The governor's declaration of a state emergency initiates the operation of the State Emergency Operations Plan, which is continually updated by SEMA to meet changing conditions.

SEMA's **Logistics, Mitigation and Floodplain Management Branch** services three areas very important to Missouri's residents. The efforts of the Mitigation Section are designed to lessen or avoid the adverse impact that disasters inflict on lives and property of Missouri's residents and visitors. To do this, the section administers five federal mitigation grant programs and has helped the nearly 800 Missouri counties and communities that now are covered by FEMA-approved hazard mitigation plans qualify for these grants. Under the voluntary flood mitigation buyout programs that followed the Great Flood of 1993, more than 4,500 residential properties have been acquired, demolished and deed restricted to remove them permanently from harm's way and help the homeowners avoid financial harm. Additionally, mitigation grants have funded the replacements of bridges and low water crossings as well as creek bank stabilizations and rechannelizations to lessen the threat of future flood hazards. In cooperation with Missouri's rural electric cooperatives, the section has also used mitigation grants to increase the number of NOAA weather warning transmitters, providing early warning coverage to nearly the entire state. And in recent years, the need to mitigate tornado and severe wind damages has become increasingly urgent, resulting in the growing use of mitigation funding to construct multiple school and community tornado safe rooms around Missouri.

The Floodplain Management Section administers the National Flood Insurance Program (NFIP). Floods are one of the most common hazards in the State of Missouri, and even an inch of water can cause costly property damage. For those who live in a mapped Special Flood Hazard Area, federal law compels federally backed mortgage lenders to require the purchase of flood insurance. However, anyone could actually be subject to flooding, and for this reason, all residents, even those not located in a high risk area, are eligible to purchase flood insurance if the community participates in the NFIP. The Floodplain Management Section works with the 591 NFIP participating communities, conducting community assistance program compliance visits and providing technical assistance that ensures continued NFIP participation. The section's staff also manages much of the flood insurance rate map work performed under the federal map modernization program. In addition, the section partners with the Missouri Floodplain and

Stormwater Managers Association and others to offer extensive training for local floodplain managers, insurance agents, elected officials, engineers and surveyors, and lenders and realtors. Missouri now has 77 nationally Certified Floodplain Managers. During fiscal year 2006, the section held 17 additional workshops throughout the state, training 843 people.

The Logistics Section is responsible for disaster logistics planning, training, preparedness, response, and recovery operations. The timely and effective provision of emergency life-sustaining supplies such as food, water, ice, infant items, bedding, clothing, and other emergency items is critical to those suffering adversely from a disaster. During an event, the section's staff must rapidly analyze the logistics situation, including locally available support and shortfalls to determine the appropriate logistics support required. As evidenced during the many emergencies and disasters that occurred in 2006, the Logistics Section coordinates, integrates, and tracks the efforts of multiple state, local, volunteer, and private stakeholders who perform the requisition, acquisition, delivery, reception, and distribution of personnel, equipment, supplies, and materials in support of key aspects of disaster operations. As the disaster response matures into recovery, the Logistics Section coordinates the redeployment of nonconsumable equipment and supplies to the proper owners.

The **Planning and Disaster Recovery Branch** manages the All-Hazard Planning and the Disaster Recovery sections of SEMA. The All-Hazard Planning Section provides planning guidance and assistance to state agencies and local governments in developing and maintaining their operations plans addressing natural and manmade hazards. This includes developing and maintaining Missouri's State Emergency Operations Plan and the Hazard Analysis, which is included in Chapter 3 of this plan. The Statewide Area Coordinator Program is part of the All-Hazards Planning Section and consists of nine area coordinators that are the state's liaisons to the local jurisdictions for emergency management activities. The Disaster Recovery Section is responsible for managing postdisaster recovery assistance programs, including FEMA's Individuals and Households Program and the Public Assistance Program.

The **Operations, Training and Exercise Branch** of SEMA offers emergency management training opportunities for state and local emergency managers, public officials, members of volunteer relief organizations, and professionals in related fields. Although most courses are preparedness and response-related, there are mitigation-related courses such as the Mitigation Planning Workshop for Local Governments, Earthquake Nonstructural Mitigation Workshop, Tools for Floodplain Management, and Risk Analysis. The branch also has responsibility for the Earthquake Program, which oversees various organizations and activities, including the Missouri State Seismic Safety Commission and the Structural Assessment Visual Evaluation (SAVE) Coalition.

The **Missouri Emergency Response Commission** (MERC) is also a part of SEMA. MERC is dedicated to protecting public health and the environment by assisting communities with chemical incident prevention, preparedness, response, and recovery and by receiving, processing, and reporting on chemical information received under the community right-to-know laws.

Through lessons learned in exercises, training, and actual events, the MERC and its participating local emergency response committees improve local and state ability to manage and mitigate chemical incidents. They also are instrumental in developing local emergency operations plans for responding to, recovering from, and mitigating such incidents.

Attorney General's Office

The Attorney General's Office represents the legal interests of the state and its agencies.

Department of Agriculture

The Missouri Department of Agriculture sets agriculture policy and provides assistance to farmers throughout the state. The Department of Agriculture is involved with issues in drought mitigation and planning and in the mitigation of agricultural damage from hazard events.

Department of Conservation

The Department of Conservation owns many undeveloped floodplain areas that provide floodway during high flows. It is also a member of numerous levee districts that provide flood protection to crops and structures. All lakes owned by the Department of Conservation with dams over 35 feet high are designed in accordance with the criteria of the Dam and Reservoir Safety Council of Missouri. The safety or redundancy factor built into these dams and levee construction projects is much higher than for normal, commercially constructed projects. In addition, the department owns facilities for launching and landing boats that regularly flood and are designed to be "low profile" and relatively flood-proof.

The Department of Conservation also participates in a statewide wildfire control program in cooperation with the forest industry, rural fire departments, and other agencies. Prescribed burning of prairies, glades, and savannas may increase the risks of fire hazards; however, prescribed burning reduces the availability of fire fuels and the potential for future, more serious fires. The Department of Conservation, in coordination with SEMA, also performs endangered species reviews for proposed FEMA-funded mitigation projects.

Department of Economic Development

The Department of Economic Development (DED) administers the Community Development Block Grant program and various mitigation projects in Missouri, including the acquisition of flood-prone homes and businesses. The DED also administers programs for "distressed and targeted" communities.

Department of Health and Senior Services

The Department of Health and Senior Services (DHSS) plans for the public health issues related to emergency response and terrorism, including biological, chemical, and radiological/nuclear threats, pandemic influenza, and natural disasters. The Missouri Center for Emergency Response

within the DHSS is responsible for coordinating regional and state planning for public health emergencies and disasters, including biological, chemical, and nuclear terrorism. Through partnerships with hospitals and other healthcare organizations; local entities, including government and law enforcement agencies; and other partners, the center works to assure systems are in place to protect the health of Missourians during a public health emergency. The department also has responsibility for planning related to the Center for Disease Control and Prevention's Strategic National Stockpile, which provides life-saving medications and supplies in the event of a large health catastrophe.

The Division of Community and Public Health (DCPH) is responsible for areas of surveillance, disease investigation, and environmental public health. In order to further detect and analyze events of public health importance, DHSS has enhanced surveillance programs through the Public Health Emergency Preparedness grants. The Public Health Event Detection and Assessment Unit in DCPH manages the BioTerrorism Surveillance System and the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE) to provide for early event detection. The ESSENCE system works by placing chief complaints from each emergency department visit into one or more syndromic groups. The system then determines whether the number of visits in the syndromic category was higher than expected for that hospital, county, or zip code. The system can also be used to increase situational awareness by augmenting information about a known health event and its consequences.

Department of Insurance, Financial Institutions, and Professional Registration

The Department of Insurance, Financial Institutions, and Professional Registration has resources for insurance buyers, companies, and producers. The department promotes flood and earthquake insurance. It enforces *RSMo 379.975,* which requires insurers to provide information to applicants and policyholders about earthquake insurance for property located in the New Madrid Seismic Zone (that is susceptible to Modified Mercalli intensity VII or above earthquake), and *RSMo 379.978,* which requires every insurance company that insures property for earthquake losses to prepare a written disaster plan that addresses earthquakes.

Section 207 of the Flood Insurance Reform Act of 2004 requires all producers selling policies under the National Flood Insurance Program (NFIP) to be properly trained and educated about the NFIP to ensure producers may best serve their clients. The federal law directs the Department of Insurance, Financial Institutions, and Professional Registration to require producers to complete a one-time course related to NFIP the , which provides continuing education credit. Additionally, the department suggests that insurance producers advise their clients of the availability of flood insurance coverage.

Department of Natural Resources

The Department of Natural Resources (DNR) protects, preserves, and enhances Missouri's natural, cultural, and energy resources. It includes the divisions of Environmental Quality, Geology and Land Survey, State Parks, Field Services, and the Office of the Director, which

includes the Water Resources Center and the Soil and Water Conservation Program. The department administers various projects designed to reduce stream bank erosion, reduce localized flooding, improve drainage, improve discharge water quality, and ensure that dams are constructed, maintained, and operated in a safe manner. The Water Quality Program ensures the quality and quantity of Missouri's water resources and develops the State Water Plan.

The DNR's Division of Geology and Land Survey provides technical assistance, education, and guidance in the use and protection of Missouri's natural resources, interprets the state's geological setting, evaluates and interprets geological hazards and houses the state's land survey records. It provides SEMA with technical data on soil liquefaction and seismic effects and provides each county with a geological hazard assessment and assistance in its use and application. In conjunction with SEMA, it also teaches Earthquakes 101 to teachers (39 in 2006 and 32 in 2007), which includes classroom instruction and field trips.

The Division of Geology and Land Survey has evaluated proposed and existing earthen waste disposal facilities for sinkhole collapse potential since 1978. Facilities with severe collapse potential are required to mitigate the problem through design and construction changes. In the intervening years, this process has all but eliminated catastrophic failures of regulated facilities.

The state geologist and chief engineer dealing with dam and reservoir safety are located in the Department of Natural Resources. The State Historic Preservation Office (SHPO) is in the department's Division of State Parks. The SHPO, in coordination with SEMA, performs historic preservation reviews of proposed FEMA-funded mitigation projects.

Department of Public Safety

The Department of Public Safety provides legal counsel to SEMA for mitigation and other emergency management related issues, as needed. The department's Division of Fire Safety and the State Fire Marshal provide fire and life safety enforcement and education to all residents so they receive the highest quality of services to ensure safety and a sense of well being. The Missouri State Highway Patrol enforces traffic laws and promotes safety on the highways. The State Highway Patrol provides all officers with weapons of mass destruction training and gives additional terrorism training to sergeants and staff officers. They establish and maintain communications with all local police and sheriff departments. There are also four special emergency response teams located throughout the state that are available at all times.

Department of Transportation

The Department of Transportation (MoDOT) personnel provide technical assistance to various emergency management programs, including mitigation. This assistance is addressed in the SEMA-MoDOT Memorandum of Agreement and includes environmental reviews and archaeological surveys for projects funded through the Hazard Mitigation Grant Program and Pre-Disaster Mitigation program. MoDOT and SEMA collaborate on earthquake mitigation and coordinate buyout projects to ensure that there are no potential right-of-way conflicts with future

use of land for bridge and highway projects. In addition, MoDOT incorporates flood and earthquake standards into new bridge designs and is working on a database that will identify which Missouri bridges have been retrofitted to earthquake design standards. MoDOT also works on major river bridge projects and wetland reestablishment and rehabilitation. The agency also enforces hazardous materials regulations and manages the registration and licensing of carriers who haul hazardous waste through the state. HazMat response coordinators from the 10 districts work with the Department of Natural Resources on spill response.

Office of Administration

The Office of Administration enforces floodplain management regulations for state facilities. The Office of Administration's Division of Design and Construction manages the state's facilities program. It selects consulting architectural and engineering firms for capital improvements projects, administers the construction program, and assists agencies in preparing their capital improvement budget requests.

Department of Mental Health

The Department of Mental Health maintains an All-Hazard Emergency Operations Plan. The plan, developed with the input of the Mental Health Statewide Disaster Response Planning Committee, is designed to enhance department planning and response activities to minimize the effects of disaster or terrorism on DMH clients, the communities and residents of Missouri. The Department also ensures the 29 DMH facilities maintain and exercise facility emergency operations plans; provides education and training for people with special needs, schools, healthcare workers, and other first responders to mitigate the emotional impact of a disaster or terrorism event; and maintains a continuity of operations plan and a Pandemic Flu annex to mitigate the effects of displacement.

4.2.2 State Programs and Initiatives

The primary existing state programs that address hazard mitigation are briefly described in this section. Many of the programs are predisaster, as are the partnerships, plans, and policies described in subsequent sections. However, postdisaster capabilities are covered as well, such as the Structural Assessment and Visual Evaluation (SAVE) Coalition, volunteer recovery organizations, State Emergency Operations Plan, and the Drought Response Plan.

Missouri Community Buyout Program

Missouri's voluntary flood buyout program, established in 1993, is managed by SEMA's Logistics, Mitigation and Floodplain Management Branch. Since the 1993 floods, over 4,000 primary residences have been acquired through the program, which allows households in flood-prone areas to voluntarily relocate out of harms way. The acquired properties are then placed in public ownership with deed restrictions that ensure that future use of the land will not put people and property at risk to flooding disasters. The buyout program uses a mix of federal funds,

including Hazard Mitigation Grant Program, Public Assistance, and Community Development Block Grants and was recognized as a model for the nation following the devastating 1993 floods. Some local communities throughout the state have continued this program by using local funds to acquire flood-prone properties. Because of the success of this program, acquisition of flood-prone structures continues to be a priority for hazard mitigation funds available to the state. More detailed information on this program can be found in Section 7.4 Effective Use of Available Mitigation Funding.

Floodplain Management Program

Missouri has an effective and proactive floodplain management program managed by SEMA's Logistics, Mitigation and Floodplain Management Branch. Floodplain management personnel work to ensure that local governments, private enterprises, and citizens are aware of the benefits of participating in the National Flood Insurance Program (NFIP). Initiatives to improve educational and technical assistance to local communities include conducting community assistance visits and training classes and inspecting sites throughout the state. The Logistics, Mitigation and Floodplain Management Branch also institutionalized an annual workshop and joint seminars with the Flood Insurance Administration. The Natural Resources Conservation Service has given SEMA grand funds for floodplain workshops. A local guidebook and a quick reference manual developed in 2003 continue to be used by local governments.

Jurisdictions that participate in the NFIP must establish ordinances related to floodplain development. The SEMA Floodplain Management Section provides guidance and sample ordinances to communities interested in developing local floodplain programs. Coordination of the NFIP was transferred from the Department of Natural Resources to SEMA in 1995. At that time, there were 523 jurisdictions in Missouri in the National Flood Insurance Program. Currently, there are 591 jurisdictions in the program, out of 729 jurisdictions with mapped flood hazards.

Missouri is currently in the map modernization process that will produce digital flood insurance rate maps (DFIRMs) for 39 counties by 2008. Seventeen of these counties will have their DFIRMs by the end of 2007. Funding for the mapping initiative comes primarily from FEMA, though a variety of state and local sources have also contributed. Depending on community participation, funding and assistance could come from the following sources:

- Community Assistance Program—State Support Services Floodplain Mapping
- Map Modernization Management Systems Floodplain Mapping
- Cooperating Technical Partners

SEMA and five local governments (City of Lee's Summit, City of Jackson, City of Springfield, Greene County, and Cass County) participate in FEMA's Cooperating Technical Partners Program and collaborate on maintaining up-to-date flood maps and other flood hazard information.

SEMA has developed a web site for helping communities with floodplain regulations and information. Included on this the web site is the ability to draft ordinances and complete CRSCommunity Rating System applications.

Earthquake Program

SEMA has developed a multifaceted earthquake program designed to carry out earthquake awareness and preparedness programs; work with partners to promote earthquake loss reduction plans, practices, and policies that encourage earthquake mitigation; and develop better response and recovery capabilities through participation in earthquake training and exercises. The earthquake program also plans the Earthquake Awareness Week in the spring with workshops, exhibits, and speakers.

The Missouri Seismic Safety Commission is an advisory body established by the state legislature that reviews the overall earthquake preparedness in the state and makes recommendations for the government, private sector, and residents to better mitigate the effects of a major seismic event. The commission developed a Strategic Plan for Earthquake Safety in Missouri (1997) that identifies objectives and makes recommendations for earthquake mitigation. The commission also sponsors earthquake awareness activities each year, including exhibitions at the St. Louis Science Center and the State Capitol.

The Structural Assessment and Visual Evaluation (SAVE) Coalition facilitates the use of volunteer engineers, architects, and qualified building inspectors to perform damage assessments of homes following disasters such as earthquakes, floods, and tornadoes. The SAVE Coalition provides sound advice to communities and residents concerning the safety of reentering their homes following a disaster and minimizes the need for sheltering by allowing people back to their homes as soon as safely feasible. Missouri statute *RSMo 44.023* provides immunity from liability for those working in disaster volunteer programs.

SEMA and the state's Executive Department worked together to write the new Catastrophic Event (Earthquake) Annex, which has been added to the State Emergency Operations Plan as Annex Y.

Dam and Reservoir Safety Program

The Missouri Dam and Safety Reservoir Law of 1979 establishes a dam safety program in the Missouri Department of Natural Resources to ensure that dams in the state are constructed, maintained, and operated in a safe manner. This is accomplished by regulation of all nonagricultural, nonfederal dams of more than 35 feet in height and by providing technical assistance and informational resources to all dam owners. The law also establishes the Dam and Reservoir Safety Council, whose responsibilities are to adopt and amend technological guidelines, standard guidelines, rules, and regulations applicable to the permits, design, construction, maintenance operation, alteration, repair, reduction, removal, and natural physical changes that may occur to a dam or reservoir. The Department of Natural Resources coordinates

with SEMA when a problem develops with a dam. If this problem occurs after hours or on a weekend, SEMA's duty officer is notified. The SEMA duty officer responds as appropriate to the situation's needs, according to a manual of procedures.

Missouri Department of Natural Resources Stormwater Improvements

In 2001, the Missouri Department of Natural Resources awarded more than $9.9 million to 46 Missouri communities for stormwater improvements. Of these 46 communities, 7 had populations of 3,000 or less. Funding for these grants came from bond issues approved by Missouri voters in 1988 and 1998 for improvements to stormwater, wastewater treatment, and public drinking water systems. The types of projects approved included developing city and county stormwater management plans, replacing undersized drainage systems, buying and demolishing flood-prone homes, and implementing structural measures to alleviate erosion and prevent future channel degradation.

Local, State, and National Volunteer Groups

SEMA's statewide volunteer coordinator works to bring together local, state, and national voluntary organizations through the Missouri Disaster Recovery Partnership, community organizations active in disaster (COAD), and the Missouri Voluntary Organizations Active in Disaster (MOVOAD). The Disaster Recovery Partnership helps communities' plan for disaster recovery by developing and implementing a holistic approach to disaster recovery that maximizes public and private resources to facilitate an efficient and effective integrated system addressing human services, housing, infrastructure, community, and economic development issues. COADs are permanently established in communities to use community disaster education, hazard analysis, training exercises, classes for community leadership, and local emergency management plans to bring awareness to residents on the four phases of emergency management. MOVOAD is dedicated to protecting public health and the environment by assisting communities with chemical incident prevention, preparedness, response, and recovery.

Disaster Resistant Communities Program

Through the state's Disaster Resistant Community program (in conjunction with FEMA's former Project Impact program), eight Missouri communities have implemented mitigation projects in their communities. In 1998, Project Impact selected the Missouri communities of Cape Girardeau and St. Joseph to become Disaster Resistant Communities. From 1998–2000, Branson, Bolivar, Hannibal, Maryville, Neosho, and Piedmont were selected. SEMA worked with these communities to help them develop mitigation plans and projects and attended multiple mitigation planning sessions with local officials, professionals, volunteer agencies, schools, and interested residents.

Local Mitigation Planning Project

Missouri's program for local hazard mitigation planning coordinates with the state's Regional Planning Commissions and Councils of Government to help local governments meet the requirements of the Disaster Mitigation Act of 2000. As of February 2007, 94 of 115 Missouri counties (including St. Louis City), which accounts for 94 percent of Missouri's population, had hazard mitigation plans that met the requirements of both the Disaster Mitigation Act of 2000 and the Flood Mitigation Assistance Program. The local hazard mitigation planning project is described in more detail in Chapter 5 Coordination of Local Mitigation Planning. As part of this project, SEMA developed an *All-Hazard Mitigation Planning Guidebook for Communities* and a *Regional Planning Commissions Hazard Mitigation Planning Guide*.

State agencies have also developed several other emergency management guidance documents to support local emergency planning efforts. These include the Mental Health Disaster Communication Guidebooks, Preparing for Pandemic Flu: A Community Guide, and All-Hazards Planning Guide for Schools.

U.S. Geological Survey St. Louis Earthquake Hazard Mapping Project

Researchers at the University of Missouri–Rolla; Saint Louis University; Missouri Department of Natural Resources; Illinois Geological Survey; Central United States Earthquake Consortium; and the U.S. Geological Survey (USGS) are collaborating to compile subsurface geologic data and to conduct high-resolution seismic imaging investigations at over 100 locations in the St. Louis metropolitan area. These data will help to better characterize earthquake hazards and ground motion in this region. Urban seismic hazard maps differ from the USGS national seismic hazard maps in that they are higher resolution and they account for the effects of the shallow rocks, sediments, and topography on earthquake ground shaking (i.e., site effects).

National Oceanic and Atmospheric Administration StormReady Program

StormReady is a voluntary program that was developed by the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) to help communities better prepare for and mitigate effects of extreme weather-related events. StormReady also helps establish a commitment to creating an infrastructure and systems that will save lives and protect property. Receiving StormReady recognition does not mean that a community is storm-proof, but StormReady communities will be better prepared when severe weather strikes.

For each community, preparedness criteria are outlined by a partnership between the NWS and state and local emergency managers. At a minimum, communities must establish a 24-hour warning point and emergency operations center; have more than one method of receiving severe weather forecasts and warnings and alerting the public; create a system that monitors local weather conditions; promote the significance of public readiness through community seminars; and develop a formal hazardous weather plan. As of March 2007, Missouri had 16 counties, 25 communities, 1 industrial site, and 1 university that were recognized as StormReady.

National Oceanic and Atmospheric Administration Weather Radio All Hazards

National Oceanic and Atmospheric Administration weather radios are tone alert radios that provide continuous weather coverage and can be programmed to sound when severe weather watches, warnings, or other critical information is broadcast by the National Weather Service. In 1998, there were only 10 weather radio transmitters providing coverage in Missouri. Due to the joint efforts of many electric cooperatives, private businesses, the National Weather Service, FEMA, and SEMA, there are currently 34 transmitters operating in the state, providing nearly 95 percent coverage. The expanded coverage benefits everyone by providing early warnings for severe weather and giving people extra time to protect their families and their property. This project is a public-private partnership that uses mostly private, donated tower space for the transmitters.

Disaster Resistant Universities

Kansas City's Metropolitan Community Colleges (MCC) was Missouri's first Disaster Resistant University (DRU). In 2004, all Missouri colleges and universities were invited to apply for a nationally competitive DRU grant. The MCC includes five colleges in four communities in Kansas City. MCC was awarded $100,000 to develop a multicampus hazard mitigation plan to improve safety, implement loss avoidance measures, and provide a plan to improve business continuity. Developed in conjunction with the Mid-America Regional Council, the plan was approved by FEMA in March 2005.

Emergency Management Accreditation Program (EMAP)

The Emergency Management Accreditation Program (EMAP) is a standards-based voluntary assessment and accreditation process for state and local government programs responsible for coordinating prevention, mitigation, preparedness, response, and recovery activities for natural and manmade disasters. Accreditation is based on compliance with collaboratively developed national standards. Missouri received conditional EMAP accreditation in 2007. Becoming EMAP accredited means that the state has a comprehensive emergency management program on par with other top state emergency management programs.

4.2.3 Outreach and Partnerships

Missouri has several ongoing efforts to increase awareness and education about the long-term benefits of well-planned, comprehensive mitigation initiatives and to improve coordination and partnerships on these initiatives. These types of capabilities, such as newsletters, training workshops, and conferences are described below.

Interagency Hazard Mitigation Team

During the 1993 Midwest floods, an interagency hazard mitigation team was formed that was composed of representatives from FEMA, SEMA, and various state agencies and departments (i.e., Governor's Office, Department of Economic Development, Department of Natural

Resources, Department of Transportation). The 1993, 1994, and 1995 buyout projects were selected, coordinated, and managed by a small committee appointed by the governor for this specific purpose. The wisdom in this approach can be found in the results. Only six months after hazard mitigation funding became available, all projects were approved. The state members of the IHMT would later make up what is today the Hazard Mitigation Planning Team (HMPT). The group is also responsible for the monitoring, evaluation, and updating of this plan. More information on the participants and responsibilities of the HMPT can be found in Chapter 2 Planning Process.

Task Force on Flood Plain Management

In 1993, the governor established the Task Force on Flood Plain Management by executive order. The task force reviews and makes recommendations on 1) the building, rebuilding, or relocation of levees; 2) state highway and road projects in floodplains; and 3) expenditures of public funds for projects in floodplains that require state action or approval. The task force also makes recommendations to the governor regarding proposed legislation and long-term policy related to the development of housing and other private and public structures in floodplain areas.

Interdepartmental Coordination Council for Water Quality

Executive Order 06-41 created the Interdepartmental Coordination Council for Water Quality, which is chaired by the director of the Department of Natural Resources and composed of director designees from the Departments of Agriculture, Conservation, Economic Development, Health and Senior Services, Natural Resources, Public Safety, and Transportation. It was created to better coordinate the state's efforts in water resource protection, monitoring, and improvement; clean water, drinking water safety, and homeland security of Missouri's drinking water supply; wastewater and runoff; well construction and design; flood and drought management; interstate river issues; dam safety; and overall state water planning. In December 2006, the council sent a report to the governor that identified goals and objectives for meeting the task.

Public Information Program

The public information coordinator in SEMA's Executive Branch produces public awareness campaigns on a variety of natural hazards for local emergency management agencies to distribute to their media. News releases on SEMA programs and disaster response activities are distributed electronically and posted on the SEMA web site.

SEMA Newsletters

SEMA publishes a quarterly newsletter to address issues related to all aspects of emergency management including hazard mitigation. This newsletter is sent to emergency management and state and local elected officials. SEMA also publishes bulletins twice a month for first responders and officials that address issues that arise between distributions of the quarterly newsletter. The

newsletter and the bulletin are used to explain state and federal mitigation planning requirements, solicit ideas and initiatives, and highlight community mitigation success stories. The Logistics, Mitigation and Floodplain Management Branch also publishes the quarterly *Missouri Mitigation* newsletter.

SEMA/MEPA Spring Conference

The SEMA/Missouri Emergency Preparedness Association (MEPA) Spring Conference is an annual event and includes workshops on a variety of subjects, one of which addresses the mitigation program. MEPA helps coordinate emergency management officials and serves as a clearinghouse for ideas and actions to protect lives and properties in Missouri from natural and manmade disasters. Past topics of the conference have included the mitigation planning process, risk assessment, identification and development of viable mitigation projects, benefit-cost analysis, and public-private partnerships. Federal, state, and local emergency management officials; state and local elected representatives; business and industry representatives; and representatives from volunteer organizations are invited to attend.

Annual Missouri Floodplain and Stormwater Manager's Conference

SEMA supports, organizes, and sponsors the Missouri Floodplain and Stormwater Managers Association's annual conference. This event features the Certified Floodplain Manager Exam (and review) and seminars on topics such as the National Flood Insurance Program, floodplain mapping, and stormwater utilities. Speakers represent a variety of partner agencies and organizations (e.g., the Departments of Natural Resources and Conservation have given seminars on low impact design, which is based on the no adverse impact philosophy). SEMA staff also attend the annual Association of State Floodplain Managers conference.

Contractor Services

The state also uses private contractors when needed to support mitigation planning and projects. Missouri has a master services agreement with specific contractors to provide needed services related to floodplain management and hazard mitigation. Tasks have included production of digital flood insurance rate maps (DFIRM), project management for Missouri's Cooperating Technical Partners Map Modernization effort, and assistance with Pre-Disaster Mitigation program grant mentoring workshops.

Trainings and Workshops

SEMA mitigation staff schedule and conduct Mitigation for Emergency Managers workshops to educate local emergency managers on the available mitigation programs and their benefits. These workshops provide opportunity for the exchange of ideas and the development of mitigation initiatives based on the evaluation of state and local needs. The workshops also help to generate interest in the mitigation program at the local level. The Logistics, Mitigation and Floodplain Management Branch trains potential Pre-Disaster Mitigation grant program

subapplicants and conducts trainings for the National Flood Insurance Program and the Community Rating System. The branch also enabled representatives from the University of Missouri–Rolla to go to FEMA's Emergency Management Institute for HAZUS-MH and mitigation planning training. The Earthquake Program conducts training for the SAVE Coalition and as part of Earthquake Awareness Week. In addition, SEMA's Training and Exercises Branch provides professional development training to all emergency response disciplines and jurisdictions. In fiscal year 2006, the branch conducted a total of 703 courses for 18,318 students.

Regional Planning Commissions

SEMA has very successful partnerships with the state's 19 Regional Planning Commissions/Councils of Governments (RPCs). SEMA equips these partners in mitigation with tools, training, and technical support to help local governments meet state and federal mitigation requirements. Specific services the RPCs provide to local governments include local mitigation plan development and GIS support. RPCs also assist the state with the approval of local plans. Because of their involvement in local plan development, the RPCs are more cognizant of mitigation, can convey their knowledge to the local communities, and can consider the basic principles of mitigation in their other planning efforts, including transportation, comprehensive, and capital improvement planning.

Ready in 3 Program

The Ready in 3 Program provides tools and materials free of charge to schools and families in Missouri for taking steps to provide for emergency situations. The program was developed by the Missouri Department of Health and Senior Services with endorsement from SEMA and the American Red Cross.

Central United States Earthquake Consortium

Since 1983, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee have been members of the Central United States Earthquake Consortium (CUSEC), which was formed to improve public earthquake awareness and education; coordinate multistate planning for earthquake mitigation, preparedness, response, and recovery; and encourage research in earthquake hazard reduction. The earthquake program managers and state emergency management directors of the member states meet at least twice annually with CUSEC management and FEMA's regional earthquake program managers to formulate earthquake safety and mitigation programs and projects. Soils mapping developed by CUSEC was used in the HAZUS-MH models for the 2007 update of this plan.

University of Missouri Extension

The University of Missouri Extension uses science-based knowledge to help people understand change, solve problems, and make informed decisions on a wide variety of topics. The extension's Community Emergency Management Program provides education and technical

assistance to individual and families, local governments, businesses, schools, and organizations in preparing and responding to natural and manmade disasters.

4.2.4 Plans and Reports

The state has initiated several planning efforts that guide and regulate activities related to hazards mitigation; these plans are described below. SEMA's director coordinates with other state agency directors on state legislation relating to emergency preparedness, earthquake issues, and floodplain management.

State Emergency Operations Plan

Updated in 2007, the State Emergency Operations Plan (SEOP) lays a framework that will allow the State of Missouri to save lives, minimize injuries, protect property and the environment, preserve functioning civil government, ensure constituted authority, and maintain essential economic activities in the event of an emergency or disaster, natural, technological, or otherwise. Specifically, it directs the actions of state departments and agencies in response to incidents that create needs and cause suffering that most local jurisdictions cannot alleviate without assistance. Authority for the plan is set forth in Code of State Regulations 11 CSR 10-11.010 and Chapter 44, Revised Statute of Missouri.

This plan emphasizes a comprehensive approach to emergency management that strives to integrate all hazards that pose a risk to the state, all phases of emergency management, and all levels of government and the private sector. Additionally, the SEOP institutionalizes the concepts and principles of the National Incident Management System and the Incident Command System into response and recovery operations conducted within the State of Missouri. It also sets the parameters for the development of local emergency operations plans and procedures.

This functional plan consists of three components: 1) The Basic Plan is the overall guide for state emergency management activities. It contains the policies and regulations that govern emergency management and assigns responsibilities for the execution of emergency functions to various state agencies and private organizations. 2) The functional annexes provide specific direction for the essential emergency functions outlined in the Basic Plan. Functions addressed by the 25 annexes include warning, damage assessment and analysis, evacuation, hazardous materials, disaster recovery, continuity of government, terrorism, and special needs. 3) Supporting documents explain how actions are to be carried out in support of each functional annex. Supporting documents include maps, charts, and resource lists that help organizations carry out their emergency responsibilities.

Catastrophic Event Annex, 2007

SEMA's Earthquake Program and the state's Executive Department worked together to develop the recently approved Catastrophic Event (Earthquake) Annex to the State Emergency Operations Plan (SEOP) to meet the federal government's mandate that all states write a

catastrophic response plan. The purpose of this SEOP annex (Annex Y) is to provide operational concepts unique to catastrophic event planning and response and assign responsibilities to state agencies to meet the needs of local governments following a catastrophic event. It serves as a supplement to the base SEOP document and is intended to expand the response organization for a catastrophic event, which, in Missouri, is most likely to be an earthquake. Many of the operational concepts could be easily adapted to address other large-scale manmade or natural hazard events as well.

A Strategic Plan for Earthquake Safety in Missouri, 1997

This document is the product of a legislative mandate enacted in Senate Bill No. 142 in 1993, which created the responsibilities of the Missouri Seismic Safety Commission. It develops tangible, practical procedures to prepare Missouri for future earthquakes as well as other natural hazards. Its creation involved general advice from the State Emergency Management Agency and participation by state agencies and interested individuals.

Missouri Drought Response Plan, 2002

The Missouri Drought Response Plan was originally prepared by the Missouri Department of Natural Resources' (DNR) Division of Geology and Land Survey in 1995. It was updated by the DNR's Water Resources Division in 2002. The purpose of the plan is to address the need for coordinated advanced emergency planning. It complements and supports the State Emergency Operations Plan. The revised version reflects the lessons learned in responding to the drought of 1999–2000.

The drought plan divides the state into three drought management areas according to their susceptibility to drought: slight, moderate, or high. Actions in the drought plan are triggered when the Palmer Drought Index reaches certain levels. The Drought Assessment Committee (DAC), chaired by the director of the DNR, is activated in the Drought Alert Stage. The DAC then activates the Impact Task Forces, which address agriculture, natural resources and the environment, recreation, water supplies and wastewater, health, social and communications, economic, climate and weather, and postdrought evaluation.

State Water Plan

The Department of Natural Resources is directed by Missouri statutory law to "develop, maintain and periodically update a state water plan for a long-range, comprehensive statewide program for the use of surface water and groundwater resources of the state, including existing and future needs for drinking water supplies, agriculture, industry, recreation, environmental protection and related needs." The State Water Plan has two phases. Phase I includes a series of seven technical assessment documents to provide basic information about Missouri's streams and rivers, groundwater, water use, water quality, interstate water issues, hydrologic extremes, and water law. Phase II identifies regional problems and opportunities related to water use. The regions are keyed to the department's historic regional office service areas. State Water Plan staff have

helped raise awareness of Missouri River issues by sponsoring five Missouri River Constituency Conferences. Staff also analyzed the impacts of the 1993 floods in the document *Flood Report Analysis* (1996).

Missouri Water Supply Study, 2005

The purpose of this water supply study was to ensure availability of water information for effective decision making by communities and the Missouri Department of Natural Resources program managers. The scope of the study primarily addresses surface water supplies for cities and communities that are expected to experience water shortages during an extended drought. It includes analyses of 34 communities' water systems. The study was developed as a result of the state's Water Resources Law water planning mandates and done under the direction of the Missouri Drought Assessment Committee.

Missouri Division of Fire Safety Strategic Plan, 2005

The mission of the Division of Fire Safety is to provide proactive statutory enforcement, regulatory oversight, and education to protect all lives and property from the devastation of fires, explosions, and life safety perils. The strategic plan, revised in November 2005, sets goals, objectives, and strategic actions for reducing danger from fires and explosions.

Missouri Pandemic Flu Response Plan, 2006

The Missouri Department of Health and Senior Services (MDHSS) prepared this plan to provide an effective response to pandemic influenza resulting from natural causes or a terrorist attack. This response will reduce the impact on public health (i.e., reduce illness and save lives) and maintain essential services while minimizing economic loss. The response plan will be implemented after a novel influenza strain begins to spread readily from person to person. The plan is geared toward action and specific responsibilities and designed to complement existing DHSS emergency response plans.

Statewide Transportation Improvement Program, 2007–2001

The Statewide Transportation Improvement Program identifies all transportation projects planned by state and regional planning agencies for fiscal years 2007 through 2011. The program includes projects for highways, bridges, transit, aviation, rail, waterways, enhancements, and other projects. It is a project-specific document that tells Missourians what improvements to expect on their transportation system during this period. Projects consider and include mitigation, specifically as it relates to flooding and earthquakes. This five-year plan is updated each year, and as one year of work is completed, a new fifth year is added.

4.2.5 Policies and Regulations

There are currently no state laws, codes, or regulations that specifically address the topic of hazard mitigation. With a few exceptions, local governments in Missouri have generally been

opposed to establishing mitigation-related codes and standards. This continues to be a difficult hurdle to overcome. The state has several statutes that address hazard mitigation through the creation of special councils or committees and rules and requirements for agencies and local governments. These primarily address seismic hazards, floodplain management, water resources, and dam and reservoir safety. Table 4.3 summarizes the statutes and executive orders that enhance the state's capabilities to reduce the impacts of future disasters.

Table 4.3. Missouri State Policies Related to Hazard Mitigation

Policy	Requirements
RSMo 44.020: State Emergency Management Agency created	There is hereby created within the military division of the executive department, office of the adjutant general, the "State Emergency Management Agency," for the general purpose of assisting in coordination of national, state, and local activities related to emergency functions by coordinating response, recovery, planning and mitigation. This agency shall also serve as the statewide coordinator for activities associated with the National Flood Insurance Program.
RSMo 44.028: State may accept federal goods and services on behalf of itself and its subdivisions	Whenever the federal government or officer or agency thereof shall offer to the state, or through the state to any political subdivision thereof, services, equipment, supplies, materials or funds by way of gift, grant or loan, for the purpose of emergency management, the state acting through the agency, or the political subdivision, through its executive officer with the consent of the governor, may accept the offer and may receive these services, equipment, supplies, materials or funds on behalf of the state or the political subdivision subject to the terms of the offer.
RSMo 44.032: Emergency powers of governor, uses—Missouri disaster fund, funding, expenditures, procedures, purposes—aid to political subdivisions, when, procedure—expenditures in excess of $1,000, governor to approve	There is hereby established a fund to be known as the "Missouri Disaster Fund," to which the general assembly may appropriate funds and from which funds may be appropriated annually to the state emergency management agency. The funds appropriated shall be expended during a state emergency at the direction of the governor and upon the issuance of an emergency declaration which shall set forth the emergency and shall state that it requires the expenditure of public funds to furnish immediate aid and relief. The director of the state emergency management agency shall administer the fund. Expenditures may be made upon direction of the governor for emergency management, as defined in section 44.010, or to implement the state disaster plans. Expenditures may also be made to meet the matching requirements of state and federal agencies for any applicable assistance programs.
RSMo 44.080: All political subdivisions shall establish a local emergency management organization	Each political subdivision of this state shall establish a local organization for disaster planning in accordance with the state emergency operations plan and program.

Policy	Requirements
RSMo 49.600: National flood insurance program, adoption and rescission procedure-exemptions (certain second-, third-fourth-class counties)	The county commission, in all counties which have not adopted county planning and zoning, may adopt or rescind by order or ordinance regulations to require compliance with FEMA standards, necessary to comply with the National Flood Insurance Program, in any flood hazard area designated by FEMA; provided, however, that no ordinance or order enacted pursuant to this section in any county shall be effective unless the county commission or governing body of the county submits to the voters of a county a proposal to authorize the county commission or governing body of the county to adopt such an order or ordinance.
RSMo 49.605: Permits, authorized requirements for applicant	No permit required by the provisions of order or ordinance regulations adopted pursuant to the provisions of sections 49.600 to 49.615 shall be denied an applicant if the proposed construction, use or other development will not raise the flood elevation of the 100-year flood level more than one foot; provided, however, that any permit may require that the lowest floor of an insurable structure shall be above the 100-year flood level and that all structures shall be adequately anchored to prevent flotation, collapse, or lateral movement of the structure.
RSMo 49.610: Variances may be granted by county commission, when	Any order or ordinance regulations adopted pursuant to sections 49.600 to 49.615 shall provide that the county commission may grant individual variances beyond the limitations prescribed by the order or ordinance regulations upon presentation of adequate proof that compliance with the provisions will result in an exceptional hardship to applicant or any arbitrary and unreasonable closing or prevention of any lawful construction, use, or other development in the area or county and which will not result in additional threats to public safety and will not be inconsistent with the objectives of sound floodplain management.
RSMo 700.015: Code compliance required, when—seal required—exemptions from code requirements for sale of new recreational vehicles and park trailers	No person shall rent, lease, sell, or offer for sale any new manufactured home manufactured after January 1, 1974, unless such manufactured home complies with the code and bears the proper seal. No person shall manufacture in this state any manufactured home or modular unit for rent, lease or sale within the state which does not bear a seal evidencing compliance with the code. No person shall offer for rent, lease or sale a new modular unit or a unit used for educational purposes manufactured after January 1, 1974, unless such modular unit complies with the code and bears a seal issued by the commission evidencing compliance with the code.
RSMo 700.065: Manufactured homes to be anchored	All manufactured homes located in this state shall be anchored and tied down in accordance with the standards promulgated by the commission.

Policy	Requirements
RSMo 44.227-237: Commission on seismic safety created	Authorizes creation, duties, and powers of the Missouri Seismic Safety Commission, as well as gives the commission responsibilities to undertake a study to determine the feasibility of establishing a comprehensive program of earthquake hazard reduction to save lives and mitigate damage to property in Missouri.
RSMo 160.451: Earthquake emergency system to be established for certain school districts	The governing body of each school district which can be expected to experience an intensity of ground shaking equivalent to a Modified Mercalli of VII or above from an earthquake occurring along the New Madrid Fault with a potential magnitude of 7.6 on the Richter Scale shall establish an earthquake emergency procedure system in every school building under its jurisdiction.
RSMo 160.453: Requirements for emergency system—public inspection of system authorized	This earthquake emergency system shall include 1) A school building disaster plan; 2) An emergency exercise to be held at least twice each school year; 3) Protective measures to be taken before, during, and following an earthquake; and 4) A program to ensure that the students and certified and noncertified employees of the school district are aware of, and properly trained in, the earthquake emergency procedure system.
RSMo 160.455: Distribution to each student certain materials on earthquake safety—duties of school district	At the beginning of each school year, each school district shall distribute to each student materials that have been prepared by the Federal Emergency Management Agency, SEMA, or by agencies that are authorities in the area of earthquake safety and that provide the following objectives: 1) Developing public awareness regarding the causes of earthquakes, the forces and effects of earthquakes, and the need for school and community action in coping with earthquake hazards; 2) Promoting understanding of the impact of earthquakes on natural features and manmade structures; and 3) Explaining what safety measures should be taken by individuals and households prior to, during and following an earthquake.
RSMo 256.173: Cities and counties to be furnished geologic hazard assessment prepared by Division of Geology and Land Survey	The Division of Geology and Land Survey in the Missouri Department of Natural Resources shall provide each county as the information becomes available a geologic hazard assessment and assistance in the use and application of the geologic hazard assessments, which will be made available to the public. The Department of Natural Resources shall provide each recorder of deeds of each county in the state a map showing the downstream area that would be affected in the event of a dam failure.
RSMo 256.175: High seismic risk area data-duties of department	The Missouri Department of Natural Resources shall furnish to SEMA technical data, including soil liquefaction and seismic effects, on structural foundations that are located in a high seismic risk area. If requested by a local government entity, the department shall assist in the establishment of construction standards based on the data provided in this subsection. The Department shall be designated as the lead technical agency in the state to conduct studies concerning the geologic effects of earthquakes.

Policy	Requirements
RSMo 319.200-207: Notice to cities and counties subject to earthquake to adopt seismic construction and renovation ordinances, when-standards	Each city, town, village, or county that can be expected to experience an intensity of ground shaking equivalent to a Modified Mercalli of VII or above from an earthquake occurring along the New Madrid Fault with a potential magnitude of 7.6 on the Richter Scale, shall adopt an ordinance or order requiring that new construction, additions and alterations comply with the standards for seismic design and construction of the building officials and code administrators code or of the uniform building code. Cities and counties found not to comply with the requirements of sections 319.200 to 319.207 shall not be eligible to receive any state aid, assistance, grant, loan or reimbursement until compliance has been proven to the satisfaction of the commissioner of administration.
RSMo 379.975: Insurer to provide information on earthquake insurance	for coverage on property located in the New Madrid Seismic Zone, as defined by the United States Geological Survey in Missouri, susceptible to Modified Mercalli intensity VII or above from an earthquake occurring along the New Madrid Fault with a potential magnitude of 7.6 on the Richter scale, the insurer shall provide information to the applicant or policyholder regarding the availability of insurance for loss caused by earthquake.
RSMo 379.978: Written disaster plan, insurer to develop, contents	Every insurance company that insures property for loss caused by earthquake shall prepare and retain a written disaster plan covering earthquakes. This plan shall include specific provisions regarding procedures for handling claims under the insurance company's issued policies or endorsements covering loss or damage from the peril of earthquake.
RSMo 640.412: Inventory to be maintained on ground and surface water uses, quantity, and users	The Department of Natural Resources shall inventory 1) existing surface water and groundwater uses; 2) the quantity of surface water and groundwater available for uses in the future; and 3) water extraction and use patterns, including regulated and unregulated users.
RSMo 640.415: State water resource plan to be established for use of surface and ground water—annual report, contents—powers of department	Authorizes the Department of Natural Resources to develop, maintain, and periodically update a state water plan for a long-range, comprehensive statewide program for the use of surface water and groundwater resources of the state, including existing and future need for drinking water supplies, agriculture, industry, recreation, environmental protection, and related needs. This plan shall be known as the "State Water Resources Plan". The department shall collect data, make surveys, investigations and recommendations concerning the water resources of the state as related to its social, economic and environmental needs.
RSMo 644.018: Reasonable use defined in cases involving surface water in flood-prone areas	In any contested case or judicial proceeding filed after January 1, 1998, involving surface water in any flood-prone area, if any defendant has obtained and fully complied with a permit from a political subdivision which has enacted orders or ordinances as required by FEMA as a prerequisite to participation in the National Flood Insurance Program, and which political subdivision has jurisdiction, pursuant to the zoning laws of this state or the laws and regulations of FEMA, over the area in dispute, then the proper permitting and compliance with all conditions of such permitting of such project shall be conclusive proof that the project is a reasonable use and meets any reasonable-use test imposed by law or by a court.

Policy	Requirements
RSMo 236.400-425: Dam and Reservoir Safety Program and Council established	Creates a dam and reservoir safety program and "Dam and Reservoir Safety Council" in the Department of Natural Resources. The council shall consist of seven members, no more than four of whom shall be members of the same political party, appointed by the governor with the advice and consent of the senate. The council shall promulgate rules, regulations, guidelines, and standards relating to the determination of whether a dam or reservoir constitutes a danger to public safety, life or property to be effective upon approval by the director. The council, with the advice and assistance of the chief engineer, shall carry out a state program of inspection of dams and reservoirs in accordance with regulations adopted by the council. All dams and reservoirs in this state shall be inspected on a periodic basis to determine if they constitute a threat to public safety, life or property. Also authorizes the director of the Department of Natural Resources to appoint a chief engineer, who shall submit reports to the director and the council concerning the condition of each dam or reservoir inspected, and recommendations as to any alterations or repairs needed.
RSMo 245.015: Owners may form levee district, where—articles of incorporation to be filed in circuit court	The owners of a majority of the acreage in any contiguous body of swamp, wet or overflowed land or other property in the nature of individual or corporate franchises in this state, or land subject to overflow, wash or bank erosion, located in one or more counties or in any city, town, or village in this state not located within any county with a charter form of government and with more than two hundred fifty thousand but less than three hundred fifty thousand inhabitants, or in any city, town, or village of the third or fourth classification in this state which is located within any county with a charter form of government and with more than two hundred fifty thousand but less than three hundred fifty thousand inhabitants, may form a levee district for the purpose of having such land and other property reclaimed and protected from the effects of overflow and other water, for sanitary or agricultural purposes, or from the effect of wash or bank erosion, or when the same may be conducive to the public health, convenience or welfare, or of public utility or benefit, by levee, or otherwise.
RSMo 254.270. Fire control and timber trespass activities intensified, when—provisions for added protection	Fire control and timber trespass activities will be intensified and may be extended to include all woodlands in the state as deemed in need of such protection by the commission within the limits of funds provided. Any person whether or not his lands are classified as forest croplands may receive such assistance. Any owner may make application to the commission for special attention in forest fire control requiring expenditures in excess of those permitted within the limits of funds provided for general activities under this chapter, by subscribing a payment of not less than three cents per acre per year for such added protection as the commission may deem advisable and desirable.

Policy	Requirements
RSMo 236.455: Emergency Action Authorized	If it is determined at any time that the condition of a dam or reservoir is an imminent and substantial threat, and so dangerous to public safety, life, or property as not to permit time for issuance of an enforcement order to correct the hazard, the chief engineer may take any appropriate action not prohibited by the constitution or laws of this state he deems necessary for emergency protection of public safety, life or property, and may request the attorney general or a prosecuting attorney to take any legal steps necessary to accomplish such action and to recover the cost of such measures from the owner by appropriate legal action.
RSMo 640.130: Emergencies—actions to be taken—water systems in violation, penalties	Whenever the Department of Natural Resources determines that an emergency exists which endangers or could be expected to endanger the public health and safety with regard to drinking water supplies, the department may, without notice or hearing, issue an order reciting the existence of such a condition and requiring the person to take such action as will lessen or abate the danger. At the request of the department, the attorney general may bring an injunctive action or other appropriate action in the name of the people of the state Whenever the department determines that a public water system is in violation … it may issue an administrative order requiring the public water system to comply with such rule or statute.
RSMo 640.140: Department may cooperate with others—may receive aid, conduct training and research—may financially assist in construction of water systems	The Department of Natural Resources may enter into agreements, contracts, or cooperative arrangements under appropriate terms and conditions with other state agencies, federal agencies, interstate agencies, political subdivisions, educational institutions, local health departments, or other organizations or individuals for the purpose of administering the state drinking water supply program. The department may solicit and receive grants of money or other aid from federal and other public or private agencies or individuals … to conduct research and training activities or cause them to be conducted, to financially assist in the construction of water works systems or portions thereof, or for other program purposes.
RSMo 319-500: Pipelines transporting hazardous liquids to submit periodic reports to department of natural resources—content	Any owner or operator of pipelines transporting hazardous liquids, as defined in the federal Hazardous Liquid Pipeline Safety Act of 1979, 49 USC 2001, et seq., shall submit periodic reports to the department of natural resources as required by the director of the department of natural resources under this section.
Executive Order 82-19, 1982	Potential effects of actions taken in a floodplain should be evaluated to avoid adverse impacts.
Executive Order 93-40, 1993	Establishes the Task Force on Flood Plain Management and the composition of its members. The task force reviews and makes recommendations on 1) the building, rebuilding, or relocation of levees; 2) state highway and road projects in floodplains; and 3) expenditures of public funds for projects in floodplains which require state action or approval. The task force will make recommendations to the governor regarding proposed legislation and long-term policy regarding development of housing and other private and public structures in floodplain areas.

Policy	Requirements
Executive Order 94-25, 1994	Establishes the Disaster Recovery Partnership to review and design new human services disaster response and recovery delivery methods, establish more rapid and complete communications to disaster victims and caregivers, and promote, train, and support local committees.
Executive Order 97-09, 1997	Authorizes SEMA to issue floodplain development permits for any state owned or leased development in a special flood hazard area.
Executive Order 03-23, 2003	Reaffirms the endeavors of the Disaster Recovery Partnership and ascribes to it the additional functions of a state citizen council.
Executive Order 05-20, 2005	Establishes the Missouri Homeland Security Advisory Council to review and evaluate current state and local homeland security plans and make recommendations for changes to better protect Missourians and to review requests and provide recommendations on the appropriate use of Homeland Security grant funds from the federal government. Creates the Division of Homeland Security within the Department of Public Safety to coordinate activities to promote unity of effort among federal, state, local, private sector, and citizen activities related to emergency preparedness and homeland security.
Executive Order 06-41, 2006	Creates the Interdepartmental Coordination Council for Water Quality.

4.2.6 Development in Hazard-Prone Areas

Missouri is a “home-rule” state and does not have a statewide program for land use or a statewide building code; however, the state does address development in seismic and flood hazard areas. State statutes require that new construction, additions, and alterations comply with certain standards for seismic design and construction if located in areas subject to a certain level of ground shaking. It is up to local governments to implement and enforce the use of building codes. The HMPT, during the 2007 update, noted that an ongoing implementation opportunity and challenge is the need for continued emphasis on the use of building codes as a mitigation tool. This is being accomplished by providing comprehensive CDs with mitigation information to the emergency management directors, chief executive officers, and Regional Planning Commissions. SEMA emphasizes the use of building codes at every opportunity, including when briefing new legislators.

As a result of a 1997 executive order, SEMA issues floodplain development permits for any state-owned or leased development in a special flood hazard area. Local governments participating in the National Flood Insurance Program address development in flood hazard areas through their floodplain management ordinances. In addition, through the Community Buyout Program, the state works with local communities to voluntarily relocate structures out of flood-prone areas. The Missouri Department of Transportation and SEMA coordinate buyout projects to ensure that there are no potential right-of-way conflicts with future use of land for bridge and highway projects. The Community Buyout Program continues to be an effective tool in removing existing property and preventing future losses in floodplains, as demonstrated in Section 7.5 Effective Use of Available Mitigation Funding. The evaluation of this program during the 2007

update identified some challenges and shortfalls. These are noted in Section 4.2.9 Implementation Opportunities and Challenges.

4.2.7 Funding Capability

The majority of funding for hazard mitigation projects is attained through federal programs. More information on these funding sources is provided in Section 4.5 Funding Sources. The state's funding capabilities for mitigation projects include partial funding of the floodplain management budget, the DNR Stormwater Grant Program, and SEMA's operating budget, which helps support mitigation programs and staff:

- State funding for floodplain management has increased.
- In the past, Missouri voters have approved bond measures to provide grant funding for improvements to stormwater, wastewater treatment, and public drinking water systems through the Missouri Department of Natural Resources' Stormwater Grant Program.
- SEMA's funding sources for operating expenses in fiscal year 2006 consisted of 90.5 percent from federal sources, 7.6 percent from general revenue, and 1.9 percent from other funds. Funding for SEMA through general revenue and other funds was approximately $7.6 million.

Section 44.032 of the Missouri Revised Statutes establishes the Missouri Disaster Fund to "furnish immediate aid and relief." The fund is primarily for response and recovery costs, but the section states that "provisions of this section shall be liberally construed in order to accomplish the purposes of sections 44.010 to 44.130. Section 44.010 defines emergency management functions, emergency management activities, and emergency management service as "those functions required to prepare for and carry out actions to prevent, minimize and repair injury and damage due to disasters."

4.2.8 Changes and Challenges in Capabilities

As the Missouri State Hazard Mitigation Plan has evolved, almost all aspects of mitigation capabilities have grown. An evaluation of the pre- and postdisaster capabilities took place on a program level during the 2007 update. This program-level evaluation was based on increases in community participation in programs such as the National Flood Insurance Program (NFIP) and StormReady, planning efforts, successful acquisition of new pre- and postdisaster mitigation project funds, and peer evaluation of the state's emergency management program. A greater number of communities are participating in the NFIP, partnerships among federal and state agencies and local governments continue to grow, and new strategic planning efforts have been undertaken. These changes in programs, outreach and partnerships, plans, and policies and regulations are summarized below. The end of this chapter discusses the challenges and opportunities in continuing to enhance state capabilities.

SEMA's overall program has been strengthened by legislation (Missouri House Bill 579) that transfered SEMA from the Office of the Adjutant General to the Department of Public Safety and allows for the deployment of any healthcare provider who is licensed, registered, or certified

in Missouri or any other state and volunteers during an emergency declared by the governor. Prior to the bill's passage, only workers licensed, registered, or certified in Missouri could be deployed. The bill granted volunteers immunity from civil damages for their services unless the damages are due to willful and wanton acts or omissions in rendering care. The Department of Health and Senior Services is allowed to recruit, train, and accept the services of citizen volunteers to dispense medication in a public health emergency.

Another indication that SEMA's overall emergency management program is maintaining a standard of excellence is the conditional accreditation for the Emergency Management Accreditation Program (EMAP) that it received from the National Emergency Management Association in 2006. SEMA underwent the EMAP voluntary assessment which is a peer-reviewed evaluation and accreditation process for state and local government programs responsible for coordinating prevention, mitigation, preparedness, response, and recovery activities for natural and manmade disasters. Accreditation is based on compliance with collaboratively developed national standards. By complying with the EMAP mitigation standards, Missouri has demonstrated the importance it places on emergency management, including mitigation, and is better prepared to protect its residents and property from hazards.

Participation in the NFIP has increased between the publication of the 2004 plan and January 2007 (see Table 4.4). Eight communities from the emergency program have moved to the regular program and an additional 21 communities have joined the program. Mitigation planning and the Pre-Disaster Mitigation grant program have had a positive impact on NFIP interest and participation. The program is expected to continue to grow. Many communities have had their flood hazards newly mapped but have not yet joined the program. The number of total suspended communities has increased by one.

Table 4.4. Changes in NFIP Participation, 2004-2007

NFIP Participation	2004	2007
Total in Regular Program	555	584
Total in Emergency Program	15	7
Total in NFIP	570	591
Mapped Hazard Area, Not in Program	89	138
Total Suspended	12	13

Source: NFIP Community Status Book January 2007

As part of Missouri's map modernization efforts, four counties were mapped for flood hazard areas in 2005 by the University of Missouri Center for Agriculture, Resource and Environmental Systems (CARES); these were Marion, McDonald, Pike, and Ralls counties. The Geographic Resources Center produced flood maps for four more counties: Audrain, Howard, Montgomery, and Warren. The U.S. Geological Survey mapped two counties: Franklin and Boone. Between 2006 and 2008, scoping meetings and reports will be developed for 39 counties, of which 27 will get updated floodplain maps.

SEMA organized three Pre-Disaster Mitigation (PDM) grant mentoring workshops, one each for the 2005, 2006, and 2007 grant cycles, to help local governments develop PDM subgrant applications and benefit-cost analyses. The workshops assisted 40 local governments with their applications. The 2005 grant cycle workshop resulted in the success of 76 percent of the applicants.

When the Hazard Mitigation Planning Team prepared the 2004 Missouri State Hazard Mitigation Plan in 2004, local mitigation plans were largely unavailable and local information was limited. Within the past three years, 82 percent of Missouri counties have successfully completed and received FEMA approval for their hazard mitigation plans. As of February 2007, 94 percent of Missourians were covered by a local hazard mitigation plan. In regard to these local planning efforts, the RPCs proved themselves to be an extremely valuable capability, in developing and approving plans and in increasing awareness of mitigation and integrating it with other planning efforts. For more information on completed local hazard mitigation plans, see Section 5.1.2 Local Plan Development Status.

Since 2004, Missouri has completed the Draft Catastrophic Event (Earthquake) Annex, Pandemic Flu Plan, and Fire Safety Strategic Plan and updated the State Emergency Operations Plan and the Missouri Water Supply Report.

Since the 2004 plan, Missouri has made significant progress in preparing its communities for severe weather. With a total of 43 StormReady designations, Missouri more than doubled the number of counties participating in the voluntary program, increased the number of communities, and added a university. In 2004, there were 7 counties, 20 communities, and 1 commercial site, and in early 2007, there were 16 counties, 25 communities, 1 commercial site (there are only 5 nationwide), and 1 university.

There have not been changes in mitigation-related laws and regulations since 2004. However, the Missouri Department of Natural Resources has developed recommended revisions to the Dam and Reservoir Safety Law. These revisions would change the definition of “dam” and “dams to be inspected” and change hazard classification of dams to follow FEMA’s Model Dam Safety Law. This would eliminate exemptions of agricultural dams, dams regulated by the Federal Power Act, and dams constructed for soil and water conservation or irrigation or relating to wildlife conservation. Currently, all regulated dams are inspected regardless of hazard class. Under the recommended revisions, the state would inspect high- and significant-hazard dams. Owners of low-hazard dams would be asked to submit a data sheet after completion of their dam and periodically provide a self-inspection report to the program. The changing of the definition of a dam and the removal of exemptions would result in the regulation of 5,000 dams. Currently, the state regulates about 600 dams.

4.2.9 Implementation Opportunities and Challenges

This section summarizes the opportunities for improving state capabilities and opportunities and challenges related to the implementation of mitigation laws, regulations, policies, and programs.

It also highlights the pre- and postdisaster tools, policies, and programs that have proven to be successful in achieving Missouri's mitigation objectives.

As mentioned previously, the Local Mitigation Planning Project has been quite successful. Ninety-four percent of Missouri's population is covered by an approved hazard mitigation plan, and this is largely because of SEMA's partnership with the RPCs. This relationship is making mitigation champions out of the RPCs, and as they work on other planning efforts they are able to use multiobjective management and consider where and how mitigation can be incorporated. SEMA will continue to use the RPCs and provide them with support and education to further the mitigation cause.

Mitigation planning, especially at the local level, has greatly increased the awareness and importance of mitigation throughout the state. This has subsequently increased interest in mitigation grant programs and the number of applications for project funding from eligible applicants to meet local plan goals and objectives. This is both a success and a challenge due to increased workloads.

SEMA's mitigation program has historically maintained a staffing level to manage approximately $25 million in grants. However, due to the program's success in obtaining funding through the competitive Pre-Disaster Mitigation program and multiple disasters, SEMA is managing an anticipated $79 million. This presents challenges for personnel time. SEMA has met this challenge by contracting with the Regional Planning Commissions for planning, plan reviews, and completing closeout reports. Also, the governor recently approved a budget in 2007 that will allow for the addition of another contracted full-time employee specifically for the Mitigation section that will work with local plans and grants on a regular basis.

The Community Buyout Program remains an important tool, both pre- and postdisaster, for moving people and property out of flood hazard areas. One challenge of the program is the lack of flexibility in developing alternate public uses of acquired properties, such as for bridges or public transportation right-of-ways. Another is ensuring the communities know about and comply with the deed restrictions. While this program and other flood-related mitigation actions are still the state's top priority, tornado safe rooms are becoming requested more and more in the wake of the tornado activity in the past few years.

The Missouri Water Resources Law addresses water inventory and monitoring, source water assessment and protection, dam safety, and the Water Plan; however, no state water appropriations law exists. This presents a challenge as demands on water resources continue to increase.

Missouri Revised Statute 245.15 allows for the creation of levee districts to protect land subject to overflow, overwash, and bank erosion. Because Missouri is a home-rule state, it has limited authority over these levee districts. FEMA Region VII is developing a strategy for the evaluation of the certification or decertification of existing or proposed levees. SEMA supports FEMA in development of this strategy.

Counties that are designated as third or fourth class based up on their assessed valuation cannot implement certain zoning and land use regulations. Among these regulations are floodplain ordinances necessary to comply with the NFIP. *RSMo 49.600*, listed in Table 4.3, mandates that in certain second-, third-, or fourth-class counties no floodplain ordinance is effective unless authorized by voters.

More information on successful mitigation programs and projects in Missouri can be found in Section 7.5 Effective Use of Available Mitigation Funding.

4.3 Local Capability Assessment

Requirement §201.4(c)(3)(ii):	The mitigation strategy shall include a general description and analysis of the effectiveness of local mitigation policies, programs, and capabilities.

The local capability assessment provides a general description of local mitigation capabilities in Missouri, including examples of successful policies and programs, followed by an analysis of the effectiveness of these capabilities based on local evaluations. The assessment concludes with a discussion of obstacles and opportunities to implementing and strengthening local capabilities.

4.3.1 Methodology

The HMPT analyzed FEMA-approved local hazard mitigation plans to inventory capabilities and assess their effectiveness. SEMA's 2002 local mitigation planning guidance recommended and provided information for the development of a capability assessment, which goes beyond the minimum local planning requirements of the Disaster Mitigation Act and enabled this inventory and analysis. A table created to capture typical local capabilities was provided in SEMA's guidance document. To develop a summary of local capabilities, the HMPT developed a database and populated it, primarily, with information from capabilities tables of the 94 FEMA-approved local plans. Information related to the following categories of capabilities was captured:

- Personnel
- Technical
- Fiscal
- Land Use Planning and Building Codes
- Coordination and Partnerships
- Education and Outreach
- Other Capabilities

In the 2002 SEMA local mitigation planning guidance, local governments were asked to evaluate the effectiveness of policies and programs for mitigation as low, medium, or high. Using data from the local plans that contained evaluations, the HMPT was able to assess how local

governments perceive the effectiveness of commonly identified local capabilities. These capabilities were multihazard emergency plans, floodplain management, stormwater regulations, building regulations, flood insurance, and Mississippi River levees.

4.3.2 Local Policies, Programs, and Capabilities

A general description of local capabilities, both existing and emerging, from the analysis of local plans is summarized below for each of the categories of capabilities identified in the methodology.

Personnel

The state reviewed FEMA-approved local plans for information on personnel capabilities, including whether the local government has an identified emergency manager or emergency coordinator and if there are other staff positions that enhance mitigation capabilities. Of the counties with available data (77), about 87 percent reported having an emergency manager or coordinator.

Other personnel capabilities vary greatly across the state. Larger, wealthier counties have full-time planners and engineers; smaller, poorer counties do have not full-time planners or engineers. Other personnel capabilities include administrators for grant funding programs. Some counties described the need for a full-time information technology manager to enhance their technical capabilities and to better utilize geographic information systems (GIS) data.

Technical

The primary technical capability evaluated by the local governments was GIS analysis, which is valuable for mapping hazard areas and comparing hazards areas with vulnerable areas and assets in the community. Many plans identified GIS capabilities. Regional Planning Commissions (RPCs), who were contracted by the state to develop local hazard mitigation plans, provided some GIS support to smaller rural counties to help them complete their plans. Other technical capabilities discussed in local plans include joint communications centers and advanced warning systems.

Fiscal

The analysis of local plans indicates that most local governments do not have specific local funding sources for mitigation and rely on federal programs, such as the Hazard Mitigation Grant Program, Pre-Disaster Mitigation program, and Flood Mitigation Assistance Program, to fund pre- and postdisaster mitigation projects. Through tax-funded investments in infrastructure improvements, local governments are able to fund some projects that have mitigation effects, such as replacing culverts or structural improvements to critical facilities. These funds come predominantly from property and sales tax revenues and are generally allocated directly to schools, public works, and other essential government functions. Mitigation can be accomplished

with this revenue stream through projects that meet multiple objectives. For instance, money allocated for school repairs can be used to replace a school's roof with one more resistant to high winds.

Some counties and municipalities have a dedicated transportation or capital improvements sales or use tax that can be used to fund mitigation projects. Many counties have fully allocated their current tax collections and do not have significant additional amounts for mitigation projects. A sales tax or bond issue to help fund mitigation actions would require a vote of the citizenry and could be difficult to pass. In the City of Holts Summit in Callaway County, voters approved a one-eighth cent sales tax in 2001 for emergency preparedness. This tax funds the emergency preparedness director, installation of a citywide warning system, emergency backup generator system for police and city hall, and will fund additional programs and projects in the future.

Several of the local plans suggested that local residents should be encouraged to fund their personal mitigation efforts rather than rely on government agencies. The local governments recognized that this would require better education and outreach to the public about hazard mitigation.

Land Use Planning and Building Codes

The HMPT also examined the adoption of land use plans, regulations, and building codes as they pertain to hazard mitigation. SEMA's guidance document for local hazard mitigation plans suggested that plans address the existence of the following regulatory and planning capabilities:

- Comprehensive/master/general plan
- Zoning code
- Building code
- Earthquake design requirements
- Subdivision regulations
- Stormwater regulations
- Floodplain regulations

Table 4.5 displays the number of counties and cities that reported their land use and regulatory capabilities in their local plans and, of those counties and cities, the number and percent with each capability.

Table 4.5. Land Use and Regulatory Capabilities of Counties and Cities

Capability	Counties			Cities		
	Number of Counties Reporting	Number with Capability	Percent with Capability	Number of Cities Reporting	Number with Capability	Percent with Capability
Comprehensive Plan	68	31	46%	484	179	37%
Zoning Code	82	34	41%	607	277	46%
Building Code	70	19	27%	575	284	49%
Earthquake Design	25	1	4%	212	13	6%
Subdivision Regulations	62	24	39%	504	228	45%
Stormwater Regulations	62	16	26%	550	164	30%
Floodplain Regulations	83	62	75%	581	293	50%

Among both counties and cities, floodplain management regulations required for participants in the NFIP are the most common hazard-related land use regulation. The local plans indicate that 355 local governments have this type of regulation.

Less than half of the counties reported having adopted comprehensive plans, zoning codes, or subdivision regulations. Less than one-third have adopted building codes or stormwater regulations. Adopted building codes are largely a version of the uniform building code (UBC) or the Building Officials and Code Administrators (BOCA) code. These older codes have been integrated into the International Building Code (IBC), which was updated in 2006.

RSMo 319.200-207 requires that cities and counties expected to experience a specified intensity of ground shaking and located along the New Madrid Seismic Zone must adopt an ordinance requiring that new construction and alterations comply with the standards for seismic design and construction of the BOCA code or UBC. There are 47 counties located in the high earthquake hazard area identified by the statute.

Overall, jurisdictions that do have regulations in place (e.g., for land use, floodplain management, or stormwater management) tend to have corresponding master plans.

Many local plans discuss the value of land use planning and building codes for hazard mitigation but are not able to implement these measures due to their designations by the state as third- or fourth-class counties. Counties that are designated as third class based on their assessed valuation cannot implement certain zoning, land use, and building regulations without voter approval. This affects approximately 89 counties. Among the restricted regulations are floodplain ordinances

necessary to comply with the National Flood Insurance Program. *RSMo 49.600* mandates that no floodplain ordinance is effective unless authorized by voters in certain second-, third-, or fourth-class counties.

Coordination and Partnerships

Some local governments have intergovernmental or interagency committees that meet regularly. These organizations most often take the form of an emergency management committee that meets monthly. Other communities use their local emergency planning committee (LEPC) to coordinate emergency management and mitigation issues. LEPCs are required by the Emergency Planning and Community Right-to-Know Act of 1986, the purpose of which is to encourage and support emergency planning efforts at the state and local levels and provide the public and local governments with information concerning potential chemical hazards in their communities. Membership of the LEPCs includes representatives of public and private organizations as well as representatives from every facility in the jurisdiction subject to the emergency planning requirements of the act. At least one Missouri county has combined their LEPC and emergency management committee into one entity; other counties have both types of committees operating simultaneously. In one county, the hazard mitigation planning committee formed to develop the mitigation plan continues to meet regularly to coordinate and monitor mitigation activities and progress.

Another indicator of the long-term success of a local mitigation plan is its integration with other local plans and programs. Many local governments describe the coordination of their mitigation plan with their emergency operations plan. One example of a community that integrated its mitigation plan with another type of plan is St. Charles County. The St. Charles plan describes how the St. Charles County Master Plan was developed to provide a framework for planned supportable growth, which includes promoting best practice policies related to stormwater and floodplain management.

Education and Awareness

The state reviewed local plans for reference to mitigation-related education and awareness programs. Some counties promote seasonal hazard awareness campaigns and many have trained their public sector employees in hazards and emergencies. Some counties perform outreach activities for their floodplain management program or work with the media to raise awareness. Some of the counties indicated that they provide moderate to substantial curriculum on hazards and emergency management in elementary and secondary schools.

Other Capabilities

This section summarizes other local capabilities that do not fit into the previously listed categories. Some local mitigation plans describe right-of-way tree-trimming programs as a mitigation capability. Through these programs, local governments trim and maintain trees along utility right-of-ways to prevent damage to utilities during severe weather events. Gentry and

Atchison counties have water conservation programs in several of their cities that they consider to be capabilities for drought mitigation, and Christian County has a dedicated drought plan.

Several communities participated in a buyout program to mitigate flood losses by acquiring flood-prone properties. Two Missouri communities, the City of Independence and St. Charles County, currently participate in the National Flood Insurance Program's (NFIP) Community Rating System, a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements.

Many communities consider existing levees a mitigation capability. According to one county, "the largest ongoing mitigation program in the county is the levee system protecting the agricultural land in the area adjacent to the Mississippi River." However, flood control levees often result in commercial and/or residential development of the land, often wetlands, behind the levees and may provide a false sense of security from flooding. New federal certification requirements for certain classes of levees may affect local governments due to changes to flood insurance rate maps that identify additional areas in the 100-year floodplain. However, there were no levees in Missouri listed on the U.S. Army Corp of Engineers' list of levees of maintenance concern released in February 2007, which identified 122 levees throughout the county that pose an unacceptable risk of failing in a flood.

The Columbia-Boone County Storm Water Task Force was developed to advise the City of Columbia and Boone County on regulations, practices, and policies to improve stormwater quality, reduce damage to streams, minimize damage to public and private property due to increased stormwater flows, and protect the quality of life for residents of the area. The task force considers both structural and nonstructural practices in formulating its recommendations and meets monthly to discuss changes and updates to stormwater regulations. While the task force has an environmental focus, it also considers mitigation, thus it addresses multiple community objectives.

4.3.3 Effectiveness of Local Mitigation Capabilities

The HMPT analyzed the effectiveness of the most commonly identified local mitigation capabilities using the evaluations of effectiveness from the local plans. Table 4.6 provides data on the effectiveness of local capabilities as ranked by counties that have the respective capability in place.

Table 4.6. Effectiveness of Local Capabilities as Ranked in Local Plans

Capability	Number of Counties Reporting with Existing Capability	Percent Ranking High	Percent Ranking Medium	Percent Ranking Low
Floodplain Management	32	97%	3%	0%
Flood Insurance	32	91%	6%	3%
Building Regulations	11	64%	36%	0%
Mississippi River Levees	11	36%	64%	0%
Multihazard Emergency Plan	28	25%	75%	0%
Stormwater Regulations	14	21%	64%	14%

Local plans ranked floodplain regulations as the most effective mitigation capability, with 97 percent ranking it as highly effective. Participation in the National Flood Insurance Program was ranked as being highly effective in 91 percent of the plans. Very few local plans ranked any of the capabilities evaluated as having low effectiveness for mitigation.

The majority of communities with building regulations consider them to be highly effective. Building regulations received higher rankings for mitigation effectiveness than the Mississippi River levees, multihazard emergency plans, and stormwater regulations. Of the communities protected by Mississippi River levees that assessed their effectiveness, most ranked the levees as having medium effectiveness for mitigation.

4.3.4 Opportunities for Improving Local Capabilities

This section discusses opportunities for strengthening local capabilities that have been identified based on the analysis of local programs, policies, and capabilities. The state will use these obstacles and opportunities to strengthen local capabilities identified in this assessment and to update their mitigation strategy and enhance local planning coordination.

Local Funding

The analysis of local plans indicates that most local governments use federal funds for mitigation. Local governments have met federal mitigation program match requirements through in-kind services, their general fund, and state general revenue; however, state general revenue is no longer available for this purpose.

One approach communities are using to overcome the funding obstacle is improving integration with other local plans and programs, such as capital improvement plans, to help achieve mitigation through other community objectives. Another approach is taking cost-effective mitigation measures into consideration when developing capital improvement projects.

A dedicated tax revenue source for mitigation is difficult to implement because tax increases are unpopular with the public, who are also often unaware of the real costs of disasters and benefits of mitigation. Continued public education and awareness of hazard vulnerabilities and mitigation options may help garner funding for mitigation through tax dollars and private sources. The best time to implement such a campaign is in the immediate aftermath of a disaster. A tax designated to targeted, tangible benefits, such as funding an emergency manager position and/or an advance warning system, may be more acceptable to the public. The state has had local success with federal funding programs by efficiently managing the programs and providing assistance to local governments with applications, ideas for meeting match requirements, and continued eligibility.

Public Education and Outreach

Public education and awareness about natural hazards risks and mitigation is an important component to most of the plans. Education and outreach has led to greater household preparedness, public participation in and support for mitigation policies and programs, as well as political support to address and fund mitigation needs. Seasonal hazard awareness campaigns are one outreach tool that many local governments use to enhance public awareness.

Technical Support

GIS and other technical assistance from the state remains an important resource for smaller communities with fewer capabilities. Regional Planning Commissions (RPCs) provide additional GIS and technical support to communities who need it. The state has helped and will continue to further help local governments overcome this obstacle by collecting information from local governments with limited capabilities on their most needed and useful types of technical assistance. To further assist local governments with their planning, SEMA will share with them the results of the HAZUS-MH reports, projects, and associated GIS data created for the purposes of this 2007 plan update and run for every Missouri county.

Regional Planning

The use of RPCs in Missouri to facilitate local mitigation planning has been very effective (see Chapter 5 Local Mitigation Planning Coordination for more information). As mentioned previously, the RPCs are important resources to strengthen local technical capabilities. Regional planning efforts also enable the coordination of land use issues to prevent one jurisdiction from engaging in activities that adversely affect another. As local governments begin to update their local hazard mitigation plans, partnerships with the RPCs will allow the state to exchange and reinforce information on capabilities with local governments. SEMA and the RPCs were awarded the planning award in 2004.

Local Plan Update Guidance

In 2002, SEMA produced a guidance document for the initial development of local hazard mitigation plans. FEMA has produced a how to guide for local plan updates. This will allow the

state to communicate information and encourage the strengthening and implementation of local capabilities identified in this 2007 state plan. This may include encouraging existing intergovernmental local emergency management committees to take a larger role in mitigation and in monitoring progress of the plan and its prioritized activities or encouraging better integration with community comprehensive plans, capital improvement plans, and other long-term community goals. The updated guidance can also align the monitoring and evaluation goals of the state plan with the local update process to create more effective feedback loops.

Land Use Planning and Regulations

Local governments are using land use planning to identify areas at risk to natural hazards and to keep inappropriate development out of those areas. Local governments are also starting to look at the impacts of existing and planned subdivision developments and methods to reduce or eliminate impacts. Combinations of stormwater retention projects and locally funded buyouts are making a significant difference in this area.

Floodplain Management

Local governments rank floodplain management and the National Flood Insurance Program (NFIP) as highly effective mitigation capabilities. Floodplain management and the NFIP remain key opportunities to strengthen local capabilities. The state has facilitated this by continuing to enhance its program that encourages and supports new participation in the NFIP and its Community Rating System and by helping existing participants promote and enforce their floodplain management programs.

4.4 Mitigation Actions

Requirement §201.4(c)(3)(iii):	[The state plans shall include an] identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the state is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section should be linked to local plans, where specific local actions and projects are identified.
Update §201.4(d):	[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts and changes in priorities.

This section introduces the mitigation action categories considered by the state to meet the goals and objectives of this plan. The categories are provided, followed by background on how they were identified and prioritized. This section also describes how the action categories were reviewed during the 2007 update to reflect changes in risk, progress in statewide mitigation

efforts, and changes in priorities. It then describes implementation and the progress in implementation of mitigation actions and concludes with an analysis of local actions summarized from the available local mitigation plans and the challenges associated with implementing actions.

4.4.1 Actions (Projects) That Will Be Considered by the State of Missouri

There are a number of action or project categories that SEMA and the HMPT has identified that fulfill this plan's identified goals and objectives. These projects must comply with all the federal and state requirements for mitigation funding, which generally means they must be cost-effective, environmentally sound, and technically feasible. The action categories listed below are the primary ones the state supports for addressing the hazards analyzed in this plan (it is not an inclusive list of all activities). This is followed by a brief description of the types of projects associated with each action category.

- M1—State and Local Hazard Mitigation Plans (required to qualify for mitigation funding)
- M2—National Flood Insurance Program Floodplain Management and Community Rating System
- M3—Voluntary Property Acquisitions (Flood Buyout)
- M4—Voluntary Elevation, Relocation, Floodproofing
- M5—Tornado Safe Rooms
- M6—Earthquake/High Wind Structural Mitigation Projects
- M7—Earthquake/High Wind Nonstructural Mitigation Projects
- M8—Structural/Infrastructure Mitigation Projects (including Public Assistance projects)
- M9—Buried Electric Service Lines
- M10—State 5% Initiative Projects
- M11—Technical Assistance

Action Category Descriptions

M1—State and Local Hazard Mitigation Plans

This includes activities related to mitigation planning at the state and local level and includes completing remaining local mitigation plans and updating existing plans, developing or revising guidance (as appropriate), and providing training.

M2—National Flood Insurance Program Floodplain Management and Community Rating System

This category includes promotion of participation in the National Flood Insurance Program (NFIP) and the wise use of floodplains. Activities can include floodplain management workshops, flood insurance promotion, community assistance visits, floodplain map modernization activities, streambank stabilization, and minor flood control. Communities willing to go above and beyond the minimum NFIP regulations, particularly those with large policy

bases, are encouraged to join the Community Rating System. SEMA has completed a web site that allows communities to complete and print a draft application for the Community Rating System. The site also allows communities to complete ordinances.

M3—Voluntary Property Acquisitions

These projects entail partnering with local entities to buy out properties at risk to flooding. This is SEMA's most favored, and usually most cost-effective, voluntary option because the people and property are totally and permanently removed from the path of flooding and danger. SEMA supports acquisitions of residential property only at this time. SEMA's priority is repetitive flood loss structures and severe repetitive loss properties are the state's top priority.

M4—Voluntary Elevation, Relocation, Floodproofing

These projects, in partnership with local entities and property owners, are additional ways to lessen the impacts of floods. Elevation of flood-prone properties may be used if it is generally more cost-effective and desirable over the long term (e.g., when the cost of the land is so high that a buyout is impractical). Relocation may be used if it is more practical/cost-effective or when the threat is so repetitive and/or severe that it is more advantageous to relocate a structure or structures, up to and including entire communities, entirely out of harms way. Floodproofing may be more feasible in areas of limited danger, particularly for commercial properties (the NFIP does not recognize dry floodproofing for residential structures).

M5—Safe Rooms

These are projects that protect people from tornadoes and high winds and must also comply with FEMA Publications 320 and 361, which prescribe safe room and shelter construction standards. Projects can range from rooms in homes that protect individual families to large-scale community shelters. These projects can often meet multiple community objectives, such as a combination school gymnasium/shelter. Safe rooms are stand alone shelters or internal shelters that are intended to provide protection during a short-term high-wind event, like a tornado. Safe rooms have proven to be successful during these events.

M6—Earthquake/High Wind Structural Mitigation Projects

These projects reinforce structural components of a building to resist seismic and/or high wind loads. There is an emphasis on critical facilities or facilities that would impact life safety if they were to fail due to the hazard.

M7—Earthquake/High Wind Nonstructural Mitigation Projects

These projects reduce life safety impacts and in some cases can limit damage to nonstructural building elements, such as building utility and lighting systems. Examples include window film and strapping and bracing appliances and fixtures, such as water heaters, shelves, etc.

M8—Structural/Infrastructure Mitigation Projects (including Public Assistance projects)

These projects develop structures to redirect or modify the impact of a hazard, such as a floodwall or stormwater collection system. Public Assistance refers to FEMA's postdisaster program that funds repair or replacement of damaged infrastructure and can sometimes be used for mitigation, depending on the type of damage. An example would be replacing a washed out culvert with one designed to convey higher flood flows or replacing a cylindrical corrugated pipe with a box culvert. Bridges and low water crossings are other examples that have been funded.

M9—Buried Electric Service Lines

These projects mitigate utility outages and repair costs from severe weather events such as ice storms, high winds, and tornadoes.

M10—State 5% Initiative Projects

These projects are those that are worthwhile but difficult to prove cost-effective and refer to the 5 percent of Hazard Mitigation Grant Program funds that, following a disaster, can be set aside for projects such as development of community outreach programs and materials, increasing weather radio coverage, hazard studies, warning sirens, mass care shelters, generators, etc.

M11—Technical Assistance

This category applies to various efforts from multiple state agencies to provide technical assistance, including training, in the identification and mitigation of hazards. The technical assistance can be for local governments or to update state policies and legislation. SEMA also makes a considerable effort to educate the public, local officials, government officials, schools, private associations, and businesses about the value and importance of mitigation programs. SEMA offers mitigation workshops, participates in public forums, provides one-on-one counseling, presents at conferences, provides written materials, develops guidebooks and manuals, publishes success stories, sends out press releases, offers information on the Internet, and provides training materials to local emergency managers, earthquake program partners, floodplain managers, and businesses.

SEMA's public outreach efforts support all the goals of this plan, as increased public awareness is an objective under every goal. These efforts also support the state's mitigation strategy for ensuring continued effective use of resources through a wide array of partnerships (common partnerships for public outreach include public and private radio and television stations, public and private school organizations, and service organizations (e.g., Lions, Rotary, and Elks clubs) and volunteer organizations (American Red Cross).

As documented in Section 4.4.4 Review and Progress of Mitigation Actions, Missouri has successfully secured funding for local mitigation plans and projects and state mitigation planning funds from the annual, nationally competitive Pre-Disaster Mitigation (PDM) grant program since 2002. One of the reasons for this success is the hands on technical assistance that SEMA provides to subapplicants in their grant applications and benefit-cost analyses. This has been

provided through three contractor supported PDM grant workshops for fiscal years 2005, 2006, and 2007, among others.

This assistance supports all the goals of this plan by educating eligible state, local, and nonprofit entities as to how they can secure funding for mitigation planning and projects. It also supports the state's mitigation strategy for ensuring continued effective use of resources by educating subgrantees about the process (as well as the state goals and objectives) to maximize the amount of PDM funding granted to Missouri. Projects are screened during the application process to determine if they align with local and state mitigation goals.

Table 4.7 shows how these 11 action categories meet the objectives and goals identified in Section 4.1 Hazard Mitigation Goals and Objectives and thus contribute to meeting the overall mitigation strategy. Some of these projects have already proven successful, as demonstrated in Section 7.5 Effective Use of Available Mitigation Funding.

Table 4.7. Mitigation Action Categories and Goals Crosswalk

Objectives	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
Goal 1: Improve the Protection of Human Life, Health, and Safety											
Objective 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 3	✓	✓			✓	✓	✓			✓	✓
Objective 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Goal 2: Improve the Protection of Continuity of Government and Essential Services Safety											
Objective 1	✓	✓			✓	✓	✓	✓	✓	✓	✓
Objective 2	✓	✓			✓	✓	✓	✓	✓	✓	✓
Objective 3	✓	✓			✓	✓	✓	✓	✓	✓	✓
Objective 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 5	✓	✓			✓	✓	✓	✓	✓	✓	✓
Goal 3: Improve the Protection of Public and Private Property											
Objective 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 3	✓	✓			✓	✓	✓			✓	✓
Objective 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Goal 4: Improve the Protection of Community Tranquility											
Objective 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

During the 2007 plan update, the HMPT considered the state's overall mitigation strategy in the context of the Emergency Management Accreditation (EMAP) Program's mitigation standards. EMAP is a voluntary assessment and accreditation process for state emergency management programs. Accreditation is granted only following a rigorous peer review of all aspects of a state's emergency management program. To ensure EMAP mitigation compliance, the HMPT considered the following:

1) The use of applicable building construction standards
2) Hazard avoidance through appropriate land use practices
3) Relocation, retrofitting, or removal of structures at risk
4) Removal or elimination of the hazard
5) Reduction or limitation of the amount or size of the hazard
6) Segregation of the hazard from that which is to be protected
7) Modification of the basic characteristics of the hazard
8) Control the rate of release of the hazard
9) Provision of protective systems or equipment for both cyber and physical risks
10) Establishment of hazard warning and communication procedures
11) Redundancy or duplication of essential personnel, critical systems, equipment, information, operations, or materials.
12) Educating the public about mitigation (additional measure added by SEMA—not part of EMAP)

Table 4.8 prioritizes the action categories, summarizes how each identified action category relates to the mitigation of specific hazards, identifies the primary agency responsible for implementation, demonstrates how the categories are linked to local mitigation plans, rates the categories' effectiveness, and ties the categories to EMAP considerations. Many of these action categories involve implementation of local mitigation projects. Local mitigation plans are proving to be a valuable resource for identifying new projects as funding becomes available or when disasters present new mitigation opportunities.

Table 4.8. Missouri Mitigation Action Categories Strategy Overview

Action Category	Priority	Responsible Agency for Implementation	Hazards Addressed	Link to Local Plans, Actions, and Assistance	Effective-Ness*	EMAP Mitigation Consider-ations
M1—State and Local Hazard Mitigation Plans	High	SEMA/RPCs/ local jurisdictions	All	Continued use of RPCs	High	1,2,3,4,5,6,7,8 9,10,11,12
M2—NFIP Floodplain Management and Community Rating System	High	SEMA/local jurisdictions	Flood	Community assistance visits, workshops	High	1,2,3,4,5,6, 7,8,9,12

Action Category	Priority	Responsible Agency for Implementation	Hazards Addressed	Link to Local Plans, Actions, and Assistance	Effective-Ness*	EMAP Mitigation Consider-ations
M3—Voluntary Property Acquisitions (Flood Buyout)	High	SEMA/local jurisdictions	Flood	Projects identified in local plans	High	2,3,6
M4—Voluntary Elevation, Relocation, Floodproofing	High	SEMA/local jurisdictions	Flood	Projects identified in local plans	High	1,2,3,6,9
M5—Tornado Safe Rooms	High	SEMA/local jurisdictions	Tornado	Projects identified in local plans	Moderate	1,3,6,9
M6—Earthquake/High Wind Structural Mitigation Projects	Medium	SEMA/MoDOT	Earthquake Tornado	Projects identified in local plans	High	1,3,9
M7—Earthquake/High Wind Nonstructural Mitigation Projects	Medium	SEMA/local jurisdictions	Earthquake Tornado	Projects identified in local plans	High	1,3,9
M8—Structural/ Infrastructure Mitigation Projects (including Public Assistance projects)	Medium	SEMA/MoDOT/ local jurisdictions	Flood	Projects identified in local plans	High	1,2,3,5,6,7,8,9, 11
M9—Buried Electric Service Lines	Low	Local jurisdictions/ certain utility providers	Multiple	Projects identified in local plans	Moderate	3,4,6,9
M10—State 5% Initiative Projects	Low	SEMA/local jurisdictions	Multiple	Projects identified in local plans, difficult to measure cost-effectiveness	Moderate	1,5,6,10,11,12
M11—Technical Assistance	Low	SEMA and other agencies	Multiple	Needs identified in local plan capability assessments	Moderate	1,2,3,4,5,6,7,8 9,10,11,12

Note:
*High denotes action mitigates impacts to life safety and property, moderate denotes action mitigates impacts to life safety only or property only

Also during the 2007 plan update, a matrix was created to cross-reference the EMAP standards related to hazard mitigation with the natural and manmade hazards identified in this plan. The matrix demonstrates how mitigation is being accomplished for each hazard through multiple means, as applicable to the hazard. This matrix, Table 4.9, demonstrates in detail how mitigation is integrated into the day-to-day activities of the state.

Table 4.9. Analysis of Considerations Used Daily in Fulfilling the State Mitigation Strategy

Detrimental Impacts of Hazards on:	Dam Failures	Drought	Earthquakes	Fires	Heat Wave
Use of Building Construction Standards	DNR Dam and Reservoir Safety Program prescribes standards—Dams to be constructed in excess of 25 feet tall within or adjacent to any subdivision or development must be designed by a registered professional engineer and built in accordance with accepted engineering standards and existing dams shall be certified by a registered professional engineer as safe for inhabitants within or near the subdivision Under the Seismic Safety program, DNR shall provide each recorder of deeds of each county in the state a map showing the downstream area that would be affected in the event of a dam failure MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC-20/21 training, FEMA nonstructural earthquake retrofit workshop MO Seismic Safety Commission authority was established by *RSMo 44.225–237*, also known as the Seismic Safety Commission Act. Standing committees presently consist of committees for **building codes**, land use, and planning; geoscience; preparedness, response and recovery; and public awareness and education. The commission is to establish comprehensive program of earthquake hazard reduction to save lives and mitigate damage to property in MO *RSMo 256.175*. The DNR shall furnish to SEMA technical data, including soil liquefaction and seismic effects, on structural foundations that are located in a high seismic risk area. If requested by a local government entity, the DNR shall assist in the establishment of construction standards based on the data provided in this subsection. The DNR shall be designated as the lead technical agency in the state to conduct studies concerning the geologic effects of earthquakes *RSMo 319.200–207*: Each city,	Mitigation Planning Course, Mitigation in MO Presentation Firewise programs in MO promote fire-resistant landscaping and construction materials MO Division of Fire Safety programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHSS programs

Detrimental Impacts of Hazards on:	Dam Failures	Drought	Earthquakes	Fires	Heat Wave
Use of Building Construction Standards (continued)			town, village, or county that can be expected to experience an intensity of ground shaking equivalent to a Modified Mercalli of VII or above from an earthquake occurring along the New Madrid Fault with a potential magnitude of 7.6 on the Richter Scale, shall adopt an ordinance or order requiring that new construction, additions, and alterations comply with the standards for seismic design and construction of the building officials and code administrators code or of the uniform building code. Cities and counties found not to comply with the requirements *of RSMo 319.200–207* shall not be eligible to receive any state aid, assistance, grant, loan, or reimbursement until compliance has been proven to the satisfaction of the commissioner of administration MoDOT designs and retrofits bridges to reduce seismic impacts MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness		
Hazard Avoidance through Land Use Practices	DNR Dam and Reservoir Safety Program—Dams in excess of 35 feet tall shall be inspected and approved by the DNR or other governmental regulatory agency having jurisdiction prior to the issuance of any building permits for lots situated below the lake formed by such dam (Boone	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC 20/21 training MO Seismic Safety Commission authority was established by *RSMo 44.225–237*, also known as the Seismic Safety Commission Act. Standing committees	Mitigation Planning Course, Mitigation in MO Presentation, DNR/MO Dept. of Conservation programs, U.S. Forest Service programs Firewise and conservation programs promote access minimums for fire safety response	Mitigation Planning Course, Mitigation in MO Presentation

Detrimental Impacts of Hazards on:	Dam Failures	Drought	Earthquakes	Fires	Heat Wave
Hazard Avoidance through Land Use Practices (continued)	County) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness		presently consist of committees for building codes, l**and use and planning**; geoscience; preparedness, response and recovery; and public awareness and education *RSMo 256.173*: The Division of Geology and Land Survey in the DNR shall provide each county as the information becomes available a geologic hazard assessment and assistance in the use and application of the geologic hazard assessments, which will be made available to the public MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	(driveway width, turnaround space) MO Division of Fire Safety programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	
Relocation, Retrofitting, Removal of Structures	Mitigation Planning Course, Mitigation in MO Presentation, DNR Dam and Reservoir Safety Program Projects, Dam and Reservoir Safety Council responsibilities: adopt and amend technological guidelines, standard guidelines, rules and regulations applicable to permits, the design, construction, maintenance, operation, alteration, repair, enlargement, reduction, removal or natural physical changes that may occur to a dam or reservoir pursuant to Chapter 536, RSMo	Not a vital factor	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC 20/21 training Seismic Safety Commission established to advise on comprehensive program of earthquake hazard reduction to save lives and mitigate damage to property in MO MoDOT involved in retrofitting of certain bridges to resist seismic impacts	Mitigation Planning Course, Mitigation in MO Presentation MO Division of Fire Safety programs	Not a vital factor
Remove or Eliminate the Hazard	Mitigation Planning Course, DNR MO Dam Safety Program Projects, Dam and Reservoir Safety Council responsibilities:	Not a vital factor	Missouri Emergency Response Commission HazMat Ops course FEMA Bulletin 361 Design and	Mitigation Planning Course, Mitigation in MO Presentation, DNR/MO Dept. of Conservation programs, U.S. Forest Service	Not a vital factor

Detrimental Impacts of Hazards on:	Dam Failures	Drought	Earthquakes	Fires	Heat Wave
Remove or Eliminate the Hazard (continued)	adopt and amend technological guidelines, standard guidelines, rules and regulations applicable to permits, the design, construction, maintenance, operation, alteration, repair, enlargement, reduction, removal or natural physical changes that may occur to a dam or reservoir pursuant to Chapter 536, RSMo MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness		Construction Guidance for Community Shelters MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	programs MO Division of Fire Safety programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	
Reduce or Limit the Hazard	Mitigation Planning Course, DNR MO Dam Safety Program Projects, Dam and Reservoir Safety Council responsibilities: adopt and amend technological guidelines, standard guidelines, rules and regulations applicable to permits, the design, construction, maintenance, operation, alteration, repair, enlargement, reduction, removal or natural physical changes that may occur to a dam or reservoir pursuant to Chapter 536, RSMo MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DNR Water Quality Program, USDA Rural Development programs, the State Water Resources Plan (*RSMo 640.415*), which is a provision of the Water Resources Law enacted by the MO Legislature in 1989, requires the DNR to ensure that the quality and quantity of MO's water resources are maintained at the highest possible level to support present and future beneficial uses	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC-20/21 training, FEMA nonstructural earthquake retrofit workshop RSMo 160.451: The governing body of each school district that can be expected to experience an intensity of ground shaking equivalent to a Modified Mercalli of VII or above from an earthquake occurring along the New Madrid Fault with a potential magnitude of 7.6 on the Richter Scale shall establish an earthquake emergency procedure system in every school building under its jurisdiction This earthquake emergency system shall include 1) a school building disaster plan; 2) an emergency exercise to be held at least twice each school year; 3) protective measures before, during, and after an earthquake;	Mitigation Planning Course, Mitigation in MO Presentation, DNR/MO Dept. of Conservation participates in statewide wildfire control program with the forest industry, rural fire departments, and other agencies MO Division of Fire Safety programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHSS programs, cooling stations, fan distribution programs, public information, advance weather warnings

Detrimental Impacts of Hazards on:	Dam Failures	Drought	Earthquakes	Fires	Heat Wave
Reduce or Limit the Hazard (continued)			and 4) a program to ensure that the students and certified and noncertified employees of the school district are aware of, and properly trained in, the earthquake emergency procedure system MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness		
Segregate the Hazard from That Which Needs Protection	DNR Dam and Reservoir Safety Program, in emergency situations, state can order breach of dam MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DNR/MO Dept. of Conservation programs, U.S. Forest Service programs, Defensible space programs MO Division of Fire Safety programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHSS programs, American Red Cross Mitigation Committee, volunteer programs, cooling stations, fan distribution programs
Modify the Basic Characteristics of the Threat	DNR Dam and Reservoir Safety Program, U.S. Army Corp of Engineers Flood Control Programs, in emergency situations state can order breach of dam MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DNR Water Quality Program, DHSS programs	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DNR/MO Dept. of Conservation programs, U.S. Forest Service programs, fuels management programs MO Division of Fire Safety programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHSS programs, American Red Cross Mitigation Committee, volunteer programs, cooling stations, fan distribution programs

Detrimental Impacts of Hazards on:	Dam Failures	Drought	Earthquakes	Fires	Heat Wave
Control the Rate of Release of the Hazard	DNR Dam and Reservoir Safety Program, U.S. Army Corp of Engineers Flood Control Programs, in emergency situations state can order breach of dam MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor The State Water Resources Plan (RSMo 640.415), which is a provision of the Water Resources Law enacted by the MO Legislature in 1989, requires the DNR to ensure that the quality and quantity of MO's water resources are maintained at the highest possible level to support present and future beneficial uses	Not a vital factor RSMo 160.455: At the beginning of each school year, each school district shall distribute to each student materials that have been prepared by FEMA, SEMA, or by agencies that are authorities in the area of earthquake safety and that provide the following objectives: 1) developing public awareness regarding the causes of earthquakes, the forces and effects of earthquakes, and the need for school and community action in coping with earthquake hazards; 2) promoting understanding of the impact of earthquakes on natural features and manmade structures; and 3) explaining what safety measures should be taken by individuals and households prior to, during, and following an earthquake MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DNR/MO Dept. of Conservation programs, U.S. Forest Service programs, fuels management programs MO Division of Fire Safety programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor
Provide Protective Systems or Equipment for Cyber or Physical Risks	DNR Dam and Reservoir Safety Program, DHS programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	USDA programs (animal/people), DHSS disaster healthcare programs	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC-20/21 training, building community tornado safe rooms with HMGP/PDM funds MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DNR/MO Dept. of Conservation programs, U.S. Forest Service programs, dry hydrant programs MO Division of Fire Safety programs MO Emergency Response Commission HazMat Ops course MO Emergency Response	Mitigation Planning Course, Mitigation in MO Presentation, DHSS programs, American Red Cross Mitigation Committee, volunteer programs, cooling stations, fan distribution programs

Detrimental Impacts of Hazards on:	Dam Failures	Drought	Earthquakes	Fires	Heat Wave
Provide Protective Systems or Equipment for Cyber or Physical Risks (continued)				Commission HazMat awareness	
Establish Hazard Warning and Communications Procedures RSMo 21.800: The Joint Committee on Terrorism, Bioterrorism, and Homeland Security	Emergency Alert System Owners of high hazard dams are required to have Emergency Action Plans that include warnings and communications to downstream property owners MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC-20/21 training, Emergency Alert System, Logistics Plan MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHS NIMS/ICS training, Emergency Alert System MO Division of Fire Safety programs MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHSS programs, Emergency Alert System, NOAA transmitter network
Redundancy of Essential Personnel, Critical Systems, Equipment, Information, Operations, Materials	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DNR Water Quality program, MO Dept. of Conservation programs, USDA programs The State Water Resources Plan (RSMo 640.415), which is a provision of the Water Resources Law enacted by the MO Legislature in 1989, requires the DNR to ensure that the quality and quantity of MO's water resources are maintained at the highest possible level to support present and future beneficial uses	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC-20/21 training, Logistics Plan MO Seismic Safety Commission authority was established by RSMo 44.225–237, the Seismic Safety Commission Act. Standing committees include committees for building codes, land use and planning; geoscience; preparedness, r**esponse and recovery**; and public awareness and education MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DNR/MO Dept. of Conservation programs, U.S. Forest Service programs MO Division of Fire Safety programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHSS programs, American Red Cross Mitigation Committee, volunteer programs

Detrimental Impacts of Hazards on:	Land Subsidence/Sinkholes	Riverine Flooding	Severe Winter Weather	Tornadoes and Severe Storms
Use of Building Construction Standards	Not a vital factor	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training NFIP communities required to use flood resistant materials and resist flotation, collapse, and lateral movement Executive Order 97-09 authorizes SEMA to issue floodplain development permits for any state-owned or leased development in a special flood hazard area MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness MoDOT incorporates flood standards into new bridge designs	Mitigation Planning Course, Mitigation in MO Presentation, snow loads incorporated into building codes that local jurisdictions can adopt	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC 20/21 training. FEMA Shelter Standards (Pub 361) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Hazard Avoidance through Land Use Practices Zoning is the system of land use regulation used by local governments	DNR Geology and Land Survey Program sinkhole database and geologic investigations RSMo 444.860 requires coal mine operators to adopt measures consistent with known technology to prevent subsidence Some local governments have implemented sinkhole avoidance provisions in subdivision regulations	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training NFIP communities regulate development in mapped floodplains Conservation use creates “buffers” and contributes to stormwater management Stormwater management use is a local land use option Parks use can include both conservation and stormwater management uses Executive Order 93-40: Establishes the Task Force on Flood Plain Management and its composition. The task force reviews and makes recommendations on 1) the building, rebuilding, or relocation of levees; 2) state highway and road projects in flood plains; and 3) expenditures of public funds for projects	Mitigation Planning Course, Mitigation in MO Presentation	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC 20/21 training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness

Detrimental Impacts of Hazards on:	Land Subsidence/Sinkholes	Riverine Flooding	Severe Winter Weather	Tornadoes and Severe Storms
Hazard Avoidance through Land Use Practices (continued)		in floodplains that require state action or approval. The task force makes recommendations to the governor on proposed legislation and long-term policy regarding development of housing and other structures in floodplains MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness		
Relocation, Retrofitting, Removal of Structures	The Department of Natural Resources, Division of Geology and Land Survey has evaluated proposed and existing earthen waste disposal facilities for collapse potential since 1978. Facilities with severe collapse potential are required to mitigate the problem through design and construction changes.	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training, HMGP/FMA/PDM projects, Flood Buyout Program	Not a vital factor	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC 20/21 training, safe rooms, community shelters
Remove or Eliminate the Hazard	Not a vital factor	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training, HMGP/FMA/PDM projects, DNR stormwater management programs, ASFPM education programs Adopt and amend guidelines, rules, and regulations applicable to permits, the design, construction, maintenance, operation, alteration, repair, enlargement, reduction, removal, or natural physical changes that may occur to a dam or reservoir pursuant to Chapter 536, RSMo MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation in MO Presentation MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	FEMA Bulletin 361 Design and Construction Guidance for Community Shelters MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness

Detrimental Impacts of Hazards on:	Land Subsidence/Sinkholes	Riverine Flooding	Severe Winter Weather	Tornadoes and Severe Storms
Reduce or Limit the Hazard	DNR Geology and Land Survey Program technical assistance to remediate effects of collapse DNR Soil and Water Conservation Program sinkhole Improvement to control gully erosion MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training, HMGP/FMA/PDM projects, Flood Buyout Program, DNR stormwater management programs, ASFPM education programs Adopt and amend technological guidelines, standard guidelines, rules, and regulations applicable to permits, the design, construction, maintenance, operation, alteration, repair, enlargement, reduction, removal or natural physical changes that may occur to a dam or reservoir pursuant to Chapter 536, RSMo MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects (e.g., bury electrical lines), DHSS programs, various volunteer programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Segregate the Hazard from That Which Needs Protection	DNR Geology and Land Survey Program sinkhole database and geologic investigations The Department of Natural Resources, Division of Geology and Land Survey has evaluated proposed and existing earthen waste disposal facilities for collapse potential since 1978. Facilities with severe collapse potential are required to mitigate the problem through design and construction changes MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training, HMGP/FMA/PDM projects, Flood Buyout Program, DNR stormwater management programs, ASFPM education programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor Shelter programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects, safe rooms MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness

Detrimental Impacts of Hazards on:	Land Subsidence/Sinkholes	Riverine Flooding	Severe Winter Weather	Tornadoes and Severe Storms
Modify the Basic Characteristics of the Threat	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training, HMGP/FMA/PDM projects, DNR stormwater management programs, ASFPM education programs, low water crossing project (Webster County) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	MoDOT programs, DHSS education programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Control the Rate of Release of the Hazard	DNR Geology and Land Survey Program provides technical assistance to remediate effects of collapse	Not a vital factor DNR stormwater program	Not a vital factor	Not a vital factor
Provide Protective Systems or Equipment for Cyber or Physical Risks	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training, HMGP/FMA/PDM projects, DNR stormwater management programs, ASFPM education programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	MoDOT programs, DHSS education programs, various volunteer programs (i.e., American Red Cross, etc.) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects, safe rooms MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Establish Hazard Warning and Communications Procedures	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHS NIMS/ICS training, Emergency Alert System, NOAA transmitter network, Logistics Plan MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	NOAA weather transmitter network (weather alert radios), Emergency Alert System MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	NOAA weather transmitter network (weather alert radios), Emergency Alert System MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness

Detrimental Impacts of Hazards on:	Land Subsidence/Sinkholes	Riverine Flooding	Severe Winter Weather	Tornadoes and Severe Storms
Redundancy of Essential Personnel, Critical Systems, Equipment, Information, Operations, Materials	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, Various NFIP training, HMGP/FMA/PDM projects, DNR stormwater management programs, ASFPM education programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	NOAA weather transmitter network (weather alert radios), NOAA/NWS StormReady Program MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	NOAA weather transmitter network (weather alert radios), NOAA/NWS StormReady Program MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness

Detrimental Impacts of Hazards on:	Attack (CBRNE)	Civil Disorder	Hazardous Materials	Mass Transportation Accident	Nuclear Power Plants
Use of Building Construction Standards	Mitigation Planning Course, Mitigation in MO Presentation MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation	Mitigation Planning Course, Mitigation in MO Presentation, MO Emergency Response Commission MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHSS and MoDOT training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Plants built to American Society of Mechanical Engineering Code per NRC requirements 19 CSR 20-10.070 Storage of Radioactive Materials Provisions shall be made to minimize the hazard to emergency workers in the event of fire and in situations where earthquake, flood, and windstorm potentials exist The user shall see that vaults or rooms used for storing materials that may emit radioactive gases or airborne particulate matter are ventilated in a manner that the concentration of the gases or particulate matter in the air does not constitute a radiation hazard MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness

Detrimental Impacts of Hazards on:	Attack (CBRNE)	Civil Disorder	Hazardous Materials	Mass Transportation Accident	Nuclear Power Plants
Hazard Avoidance Through Land Use Practices	Mitigation Planning Course, Mitigation in MO Presentation	Mitigation Planning Course, Mitigation in MO Presentation	Mitigation Planning Course, Mitigation in MO Presentation, MO Emergency Response Commission Low density use/buffers by local governments	Mitigation Planning Course, Mitigation in MO Presentation, MoDOT training	AmerenUE purchased 5,500 acres around the plant, donated it to the MO Dept. of Conservation for open space Buffer Zone, and does not allow building or any form of encroachment there
Relocation, Retrofitting, Removal of Structures	Not a vital factor	Not a vital factor	Not a vital factor	Mitigation Planning Course	AmerenUE purchased 5,500 acres around the plant, donated it to the MO Dept. of Conservation for open space Buffer Zone, and does not allow building or any form of encroachment there (two mile radius around plant)
Remove or Eliminate the Hazard	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Missouri State Patrol programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Missouri Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Reduce or Limit the Hazard	DHS programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Risk Management Program, Process Safety Management Program, DNR Division of Environmental Quality programs, MO Fire Marshall's Office programs, HazMat response teams, plume modeling software by fire and health departments MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Dept. of Public Safety programs, Highway Patrol, MoDOT programs, FAA air safety protocols MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	SEMA annual safety drills (NRC) graded/nongraded, SEMA Radiological Emergency Preparedness program, Mitigation Planning Course MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Segregate the Hazard From that which Needs Protection	Mitigation Planning Course, Mitigation in MO Presentation, DHS programs MO Emergency Response Commission HazMat Ops course	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course	Risk Management Program, DNR Division of Environmental Quality programs, MO Fire Marshall's Office programs, MO Emergency Response Commission, DOT evacuation guides	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response	AmerenUE purchased 5,500 acres around the plant, donated it to the MO Dept. of Conservation for open space Buffer Zone, and does not allow building or any form of encroachment there (two

Detrimental Impacts of Hazards on:	Attack (CBRNE)	Civil Disorder	Hazardous Materials	Mass Transportation Accident	Nuclear Power Plants
Segregate the Hazard From that which Needs Protection (continued)	MO Emergency Response Commission HazMat awareness	MO Emergency Response Commission HazMat awareness	MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Commission HazMat awareness	mile radius around plant) When there is a reasonable possibility that chemical, radiation, or other action might lead to leakage of radioactive material from a container, the user shall provide a secondary tray or catchment to the container adequate to retain the entire amount of radioactive material MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Modify the Basic Characteristics of the Threat	DHS programs	Not a vital factor	Risk Management Program, DNR Division of Environmental Quality programs, MO Fire Marshall's Office programs, MO Emergency Response Commission MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	MoDOT training, Dept. of Public Safety programs, MoDOT bridge/retrofit programs, DHS programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor No user shall release radioactive material into the air or water in a manner that causes exposure of any person above the limits specified in 19 CSR 20-10.040. If several users are discharging radioactive wastes to the same environs, they shall cooperate in limiting the release and shall file with the DHSS a statement of their agreed pro rata releases. MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Control the Rate of Release of the Hazard	DHS programs, NIMS/ICS training The Highway Patrol testified that it provides all officers with weapons of mass destruction training and gives additional	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response	MO Fire Marshall Office hazardous materials certification, DNR Division of Environmental Quality programs, MO Emergency Response Commission	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	SEMA Radiological Emergency Preparedness program, ALARA (as low as reasonably acceptable) NRC standard, SEMA annual safety drills (NRC) graded/nongraded

Detrimental Impacts of Hazards on:	Attack (CBRNE)	Civil Disorder	Hazardous Materials	Mass Transportation Accident	Nuclear Power Plants
Control the Rate of Release of the Hazard (continued)	terrorism training to sergeants and staff officers. They have also established and maintain communications with all local police and sheriff departments. One terrorism officer is assigned to each of the 109 zones across the state. There are four special emergency response teams (SERT) strategically located throughout the state that are available at all times. SERT members train two or three times annually with the National Guard's 7th Civil Support Team at Ft. Leonard Wood, MO. They also train with self contained breathing apparatus equipment, which they may be required to use in certain types of disasters or terrorist attacks MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Commission HazMat awareness	MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness		No user shall release radioactive material into the air or water in a manner that causes exposure of any person above the limits specified in 19 CSR 20-10.040. If several users are discharging radioactive wastes to the same environs, they shall cooperate in limiting the release and shall file with the DHSS a statement of their agreed pro rata releases MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Provide Protective Systems or Equipment for Cyber or Physical Risks	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Risk Management Program, DNR Division of Environmental Quality programs, MO Fire Marshall's Office programs, HazMat response vans MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	MoDOT programs, MO Dept. of Highway Patrol education programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	SEMA Radiological Emergency Preparedness program, buffer zone planning, table top exercises AmerenUE Firewall program controls illicit entry into controls in accordance with new NRC protocols MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness

Detrimental Impacts of Hazards on:	Attack (CBRNE)	Civil Disorder	Hazardous Materials	Mass Transportation Accident	Nuclear Power Plants
Establish Hazard Warning and Communications Procedures	Emergency Alert System The Highway Patrol testified that no existing radio or cell phone tower system can survive a major earthquake or other catastrophe. The solution is to overbuild towers and deploy mobile assets after the disaster. In a major catastrophe, communications will be lost temporarily until mobile assets can be put in place to bridge the gap. SEMA received $5.35 million in interoperable communications grants from DHS in May 2006 MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Emergency Alert System The MO chapter of the National Emergency Number Association provides a team of knowledgeable and skilled professional telecommunicators who can assist with communications in a disaster. This is one tool MO can use to restore communications, at least temporarily, until a permanent solution is available SEMA received $5.35 million in interoperable communications grants from DHS in May 2006 MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS NIMS/ICS training, MO Fire Marshall's Office hazardous materials certification, OSHA/EPA and MERC notification rules MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS NIMS/ICS training, Emergency Alert System, Metropolitan Medical Response System (St. Louis) has a critical operations group and conducts exercises In a mass casualty accident, hospitals agree to use MedComm, a data collection-dissemination system for equipment, available beds, patient tracking Each hospital agrees to back up phone/fax with radio/Internet SEMA received $5.35 million in interoperable communications grants from DHS in May 2006 MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Alert/notification system, FEMA approved warning system at plant, upgrading sirens, design report upgraded, new protocols allowing each county ability to sound the alert to other counties, similar for Cooper plant to allow either state (MO or NE) to sound the alert (first in nation) SEMA received $5.35 million in interoperable communications grants from DHS in May 2006 MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Redundancy of Essential Personnel, Critical Systems, Equipment, Information, Operations, Materials	DHS programs, NIMS/ICS training Executive Order 05-20, July 21, 2005, required all executive departments to prepare a continuity of operations plan (COOP) by November 21, 2005. The COOP is an emergency response plan or update to existing plans that addresses the continuity of each department's operations and services, as well as the security of their	DHS programs, NIMS/ICS training Executive Order 05-20, July 21, 2005, required all executive departments to prepare a continuity of operations plan (COOP) by November 21, 2005. The COOP is an emergency response plan or update to existing plans that addresses the continuity of each department's operations and services, as well as the security of their	MO Emergency Response Commission, DNR Division of Environmental Quality programs, MO Fire Marshall's Office programs, OSHA hazard communication programs (1910.1200) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	SEMA Radiological Emergency Preparedness program allowing two shifts 24/7, three personnel shifts at power plant MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness

Detrimental Impacts of Hazards on:	Attack (CBRNE)	Civil Disorder	Hazardous Materials	Mass Transportation Accident	Nuclear Power Plants
Redundancy of Essential Personnel, Critical Systems, Equipment, Information, Operations, Materials (continued)	constituents and employees in the event of a natural or manmade disaster or emergency, including a terrorist attack MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	constituents and employees in the event of a natural or manmade disaster or emergency, including a terrorist attack MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness			

Detrimental Impacts of Hazards on:	Public Health and Environmental	Special Events	**Terrorism** (See "Attack, Civil Disorder, Nuclear Power Plants, and Public Health Responses)	Utilities
Use of Building Construction Standards	Not a vital factor Radioactive materials are kept in a manner that will provide reasonable assurance that, during routine access to a controlled area, no person will be exposed in excess of the limits set forth in 19 CSR 20-10.040 MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC 20/21 training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, EQ 101, ATC 20/21 training, FCC/FTC protocols MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Hazard Avoidance Through Land Use Practices	Not a vital factor	Mitigation Planning Course, Mitigation in MO Presentation MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Relocation, Retrofitting, Removal of Structures	Mitigation Planning Course (Missouri State University has completed this planning)	Not a vital factor	Not a vital factor	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects (burying power lines)

Detrimental Impacts of Hazards on:	Public Health and Environmental	Special Events	**Terrorism** (See "Attack, Civil Disorder, Nuclear Power Plants, and Public Health Responses)	Utilities
Remove or Eliminate the Hazard	DHSS health programs, DNR environmental programs, MO Dept. of Conservation programs MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Not a vital factor MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	See Missouri Nuclear Accident Plan MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects (burying power lines) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Reduce or Limit the Hazard	DHSS health programs, DNR environmental programs The CDC conducted a mass-casualty exercise in which aerosolized anthrax was released in a highly populated city. The CDC chose this scenario because it is among the worst possible disasters requiring the distribution of drugs and supplies to millions of people. St. Louis participated in the exercise, which included 21 cities in 19 states. The CDC's goal was for states to provide prophylaxis for the entire affected population within 48 hours of a catastrophic event. Following the exercise, the CDC issued a color-coded grade to each city. Cities that received a red code were the least prepared to handle this scenario when compared to other cities. Cities that received a yellow code were moderately prepared, and cities that received a green code were well prepared compared to other cities. St. Louis received a grade of "Green – ," which indicates that, compared to the other cities that participated, it was very well prepared to handle such an	DHS programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects (burying power lines) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness

Detrimental Impacts of Hazards on:	Public Health and Environmental	Special Events	Terrorism (See "Attack, Civil Disorder, Nuclear Power Plants, and Public Health Responses)	Utilities
Reduce or Limit the Hazard (continued)	emergency. However, DHSS was quick to point out that this does not mean it can provide medication and protection for the entire population of St. Louis within 48 hours of a catastrophic event. In fact, there is no city in the nation that can do this. This exercise only indicates that MO is better prepared than most other states, but not fully prepared in a practical sense. The CDC has begun preparations for an exercise with a second group of 15 cities, one of which is Kansas City. Kansas City is currently in the planning stages. It is expected that these cities will conduct their exercise sometime in 200 MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness			
Segregate the Hazard From that which Needs Protection	DHSS health programs, DNR environmental programs, MO Dept. of Conservation programs MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, DHS programs MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects (burying power lines) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Modify the Basic Characteristics of the Threat	DHSS health programs, DNR environmental programs, MO Dept. of Conservation programs	Not a vital factor MO Emergency Response Commission HazMat Ops course	DHS programs MO Emergency Response Commission HazMat Ops course	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects

Detrimental Impacts of Hazards on:	Public Health and Environmental	Special Events	Terrorism (See "Attack, Civil Disorder, Nuclear Power Plants, and Public Health Responses)	Utilities
Modify the Basic Characteristics of the Threat (continued)	MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	MO Emergency Response Commission HazMat awareness	MO Emergency Response Commission HazMat awareness	MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Control the Rate of Release of the Hazard	DHSS health programs, DNR environmental programs, MO Dept. of Conservation programs The DHSS testified about its public health initiatives, which are funded by both the CDC and the HRSA. The situation room for the Center for Emergency Response and Terrorism is staffed at all times by a duty officer who monitors DHSS' hotlines, state agency message traffic, and breaking news. When activated, the room monitors and supports state public health and hospital response DHSS has access to the CDC's Strategic National Stockpile, which provides life-saving medications and supplies in the event of a large health catastrophe MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Provide Protective Systems or Equipment for Cyber or Physical Risks	DHSS health programs, DNR environmental programs, MO Dept. of Conservation programs MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/)	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS programs, NIMS/ICS training, DHS Buffer Zone Protection Program awarded $2.5 million for 50 sites MO Emergency Response Commission HazMat Ops course	Mitigation Planning Course, Mitigation in MO Presentation, HMGP/FMA/PDM projects MO Emergency Response Commission HazMat Ops course

Detrimental Impacts of Hazards on:	Public Health and Environmental	Special Events	Terrorism (See "Attack, Civil Disorder, Nuclear Power Plants, and Public Health Responses)	Utilities
Provide Protective Systems or Equipment for Cyber or Physical Risks (continued)	MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness		MO Emergency Response Commission HazMat awareness	MO Emergency Response Commission HazMat awareness
Establish Hazard Warning and Communications Procedures	DHSS health programs, DNR environmental programs, MO Dept. of Conservation programs DHSS testified about its public health initiatives, which are funded by both the CDC and the HRSA. The situation room for the Center for Emergency Response and Terrorism is staffed at all times by a duty officer who monitors DHSS' hotlines, state agency message traffic, and breaking news. When activated, the situation room monitors and supports state public health and hospital response DHSS has access to the CDC's Strategic National Stockpile, which provides life-saving medications and supplies in the event of a large health catastrophe MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Emergency Alert System MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Emergency Alert System SEMA received $5.35 million in interoperable communications grants from DHS in May 2006 MO DHSS Ready in 3 website (www.dhss.mo.gov/Ready_in_3/) MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	Emergency Alert System, utility based notification procedures/plans MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness
Redundancy of Essential Personnel, Critical Systems, Equipment, Information, Operations, Materials	DHSS health programs, DNR environmental programs, MO Dept. of Conservation programs MO Emergency Response Commission HazMat Ops course	DHS programs, NIMS/ICS training MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission HazMat awareness	DHS programs, NIMS/ICS training UASI grants 2003-2006: Kansas City $39.7 million St. Louis $35.7 million MO Emergency Response Commission	Mutual aid agreements between utility providers MO Emergency Response Commission HazMat Ops course MO Emergency Response Commission

Detrimental Impacts of Hazards on:	Public Health and Environmental	Special Events	Terrorism (See “Attack, Civil Disorder, Nuclear Power Plants, and Public Health Responses)	Utilities
Redundancy of Essential Personnel, Critical Systems, Equipment, Information, Operations, Materials (continued)	MO Emergency Response Commission HazMat awareness		HazMat Ops course MO Emergency Response Commission HazMat awareness	HazMat awareness

4.4.2. Process for Identifying, Evaluating, Prioritizing, and Updating Mitigation Actions

Projects in this plan were identified over years of mitigation planning in Missouri by the HMPT and its predecessors (e.g., the Hazard Mitigation Project Coordinating Group). The nature of recent disasters has often dictated the project types and hazards addressed. In the 1990s, the widespread flooding emphasized the importance, and benefits of, removing properties from the floodplain. Missouri's drought and tornado events in more recent years have shifted the local interest from flood projects to tornado safe rooms. Identification of specific local mitigation actions typically comes from communities impacted by a disaster, or in more recent years, from proactive communities with local mitigation plans applying for predisaster grant funding.

All of the mitigation actions have proven to be effective based on past experience. Some are more effective than others. Effectiveness is measured in general terms based on how well the project meets multiple objectives:

- **High—**mitigates impacts to life safety and property
- **Moderate—**mitigates impacts to life safety only or property only

For example, flood buyout projects not only remove property from the floodplain, but they remove the risk to lives in the floodplain as well and eliminate the need to put first responders' lives in jeopardy during flood events. A tornado safe room may reduce deaths and injuries, but they may not necessarily reduce property damage. Table 4.8 includes the general effectiveness of each action. Effectiveness of specific projects is measured using FEMA's benefit-cost software modules, which is described in more detail in Section 7.2.4 Cost-Effectiveness of Mitigation Measures. More communities are joining the NFIP and almost all of the counties have a FEMA-approved hazard mitigation plan.

SEMA uses STAPLEE (social, technical, administrative, political, legal, economic, and environmental) and the following criteria to rank mitigation actions:

1) Flood mitigation projects (repetitive loss properties high priority)
2) Tornadoes and high wind mitigation projects
3) Earthquake mitigation projects
4) Other, not direct life safety

STAPLEE is used as a screening tool to determine if the project makes sense and is worthy of consideration and implementation. During the 2007 update, HMPT members used STAPLEE at meeting #3 where the purpose was to update the state's mitigation goals and measures. New proposed mitigation actions developed during the planning process were presented and the HMPT were given the opportunity to review each action with the STAPLEE criteria in mind. The ideas that are presented as new actions in this plan underwent this screening as acceptable under STAPLEE. The new actions are automatically ranked using the above criteria and the mitigation action M category under which the project falls.

When several projects of the same type are considered for funding, the projects with the most direct mitigation of impacts to life safety are given top priority, in concurrence with this plan's top goal. The state uses additional criteria to rank project applications from local governments depending on the funding source applied for and the type of project. These criteria are detailed in Section 5.3.2 Project Grants and Section 7.2.3 Eligibility Criteria by Mitigation Project Type.

Projects that disturb ground, which are most construction projects, and involve the use of federal funds must undergo review for compliance with the National Environmental Policy Act to ensure that the project does not detrimentally impact the environment. Missouri uses four state agencies to conduct environmental, floodplain management, and historic reviews, as appropriate. The process for these reviews is discussed further in Section 6.2.1 Monitoring Implementation of Mitigation Measures and Project Closeouts.

During the 2007 plan update, the HMPT assessed existing actions and developed new actions for consideration based on:

- Review of the updated state risk assessment and information from local risk assessments;
- Review of goals and objectives;
- Review and assessment of existing state actions, including priorities;
- Review of state and local capabilities; and
- Review of a summary of commonly used actions identified in local plans.

This took place during two meetings of the HMPT and several SEMA meetings. A new mitigation action category called technical assistance was developed to address technical assistance actions that promote hazard mitigation. No actions from the 2004 plan were deleted or deferred, though the prioritization of the mitigation actions was changed slightly to ensure that the actions align with the priorities. The changes also reflect more recent tornado disaster events and the subsequent increase in interest in tornado safe rooms. The changes are detailed in Table 4.10, which lists only those actions that changed. The actions and goals crosswalk (Table 4.7) was also reevaluated as part of the update process but did not change except for the addition of action M11—Technical Assistance and the change in priorities of the M categories.

Table 4.10. Changes in Mitigation Action Priority 2007

Current Rank	Old Rank
M1—State and Local Hazard Mitigation Plans	M1
M2—NFIP Floodplain Management and CRS	M2
M3—Voluntary Property Acquisitions	M3
M4—Voluntary Elevation, Relocation, Floodproofing	M4
M5—Tornado Safe Rooms	M6
M6—Earthquake/High Wind Structural Mitigation Projects	M8
M7—Earthquake/High Wind Nonstructural Mitigation Projects	M9
M8—Structural/Infrastructure Mitigation Projects (Including Public Assistance Projects)	M5
M9—Buried Electric Service Lines	M7
M10—State 5% Initiative Programs	M10
M11—Technical Assistance	(New in 2007)

The 2007 plan update incorporates improvements made in the past few years to the tracking and monitoring of mitigation action progress. One of the improvements to this system is the linking of detailed actions to the M categories, as these categories represent a multitude of more detailed projects, including both local and state mitigation actions. Several new actions were identified during the update planning process that fit into the M categories. New actions are summarized in the implementation section that follows. Ongoing and completed actions and how they fit with the M categories are summarized in Section 4.4.4 Review and Progress of Mitigation Actions.

4.4.3 Mitigation Action Implementation

Implementation of mitigation actions will be accomplished according to the overall mitigation strategy presented at the beginning of this chapter. Mitigation is implemented in Missouri through:

- Existing plans, policies, procedures, and programs
- State agency activities—e.g., seismic rehabilitation of highway bridges
- Funding of local projects
- Partnering on federal, state, and local efforts and initiatives, including those of nongovernmental organizations, businesses, and industries
- Monitoring of pre- and postdisaster opportunities

Over the years, SEMA has partnered in and/or supported many of the mitigation-related efforts of state and federal agencies, businesses, educational institutions, and private associations. The following are some examples of these efforts:

- Natural Resource Conservation Service's flood detention/retention basin projects
- Stormwater management programs
- River and creek cleanup efforts
- Streambank stabilization projects

- Dam safety efforts
- Wetlands protection efforts
- Reduction of environmental damage
- Historical areas and property documentations
- U.S. Fish and Wildlife's protection of endangered species and wildlife
- Association of State Floodplain Managers' educational programs
- U.S. Army Corps of Engineers' flood control programs
- National Oceanic and Atmospheric Administration's Weather Radio All Hazards promotion
- National Weather Service's StormReady program promotion
- Underground utilities
- Automatic shutoff valves (gas and water)
- Building codes
- Bridge and highway retrofits and building to seismic design
- U.S. Geological Survey and Department of Natural Resources soil mapping and seismic studies
- Central U.S. Earthquake Consortium (programs, studies, outreach, task forces, working groups)
- SAVE (Structural Assessment Visual Evaluation) Coalition post- and predisaster inspection, Applied Technology Council training programs (ATC-20 and 21)
- Disaster healthcare programs
- Sanitation and disease prevention
- U.S. Department of Agriculture Rural Development Community safety programs
- Soil conservation and stabilization
- Integration of mitigation into multiple disciplines of planning
- American Red Cross Mitigation Committee and volunteer programs
- Homeland security programs
- Business continuity planning
- Disaster education in schools
- Disaster resistant universities

Some of these efforts are described in more detail in Chapter 2 Planning Process and Chapter 7 Enhanced Plan.

Table 4.11 details actions that the state is considering to further the implementation of mitigation actions in Missouri. The actions recommended are a result of the 2007 plan review and update that can be accomplished with state effort and/or resources. The only new sources of funding identified in 2007 in the table below are the Repetitive Flood Claims and Severe Repetitive Loss Programs.

Table 4.11. Summary of New Mitigation Actions

Action Category	Action	Plan Reference to Issue/Background	Funding Source
M1	Complete remaining local hazard mitigation plans	Chapter 5	HMGP, PDM, SEMA Operating Budget
M1	Use FEMA's guidance for local plans to address local update process and distribute to RPCs and local governments	Sections 5, 3.3, 4.3, 4.4	HMGP, PDM, SEMA Operating Budget
M1	Continue to work with RPCs during local plan updates, using new FEMA update guidance with emphasis on standard risk assessment methods	Chapter 5, Section 4.3	HMGP, PDM, SEMA Operating Budget
M1	Use RPCs and SEMA staff to encourage implementation of actions in local plans	Section 4.3	SEMA Operating Budget
M1	Develop vulnerability assessments for additional hazards besides flood, tornado, and earthquake, such as severe winter storms, for the 2010 update of the state hazard mitigation plan.	Section 3.3	HMGP, PDM, SEMA Operating Budget
M2	Continue to encourage new participation in the National Flood Insurance Program and the Community Rating System and encourage existing participants to promote and enforce their floodplain management programs	Section 4.3	FMA, CAP, HMGP, PDM, SEMA Operating Budget
M3	Enhance flood buyout and mitigation project tracking system with a goal to enable as a GIS database	Section 7.4	FMA, HMGP, PDM, SEMA Operating Budget
M4	Continue to pursue mitigation of flood-prone properties, specifically identified severe repetitive loss properties and repetitive loss properties.	Section 3.3	SRL, FMA, RFC, HMGP, PDM, CAP
M10	Create a GIS database of the locations of provisionally accredited levees, as a first step in a process to assess and prioritize needed levee projects.	Section 4.3	FMA, HMGP, PDM, SEMA Operating Budget
M11	Provide HAZUS-MH results to RPCs and local governments for mitigation planning purposes and to promote consistency in the updates to local plan risk assessments.	Section 3.3	SEMA Operating Budget
M11	Support Missouri Office of Administration's work to geolocate state facilities to further refine risk assessments using GIS. The Office of Administration is in the process of developing this information.	Section 3.4	HMGP, PDM, SEMA Operating Budget
M11	Continue to support seasonal hazard mitigation campaigns for easier adaptation and implementation by local governments	Section 4.3	HMGP, PDM, SEMA Operating Budget
M11	Expand the dam and safety reservoir program to include levees	Section 4.2 and 4.3	Missouri state funds,

Note:
HMGP (Hazard Mitigation Grant Program); PDM (Pre-Disaster Mitigation); FMA (Flood Mitigation Assistance); RFC (Repetitive Flood Claims); SRL (Severe Repetitive Loss)

Primary agencies responsible for implementation are detailed in Table 4.8 Missouri Mitigation Action Categories Strategy Overview. The implementation of some future actions, such as tornado safe room projects, is difficult to plan for, as they are dependent on local interest and support. These include action categories M3 through M9.

4.4.4 Review and Progress of Mitigation Actions

During the 2007 update to this plan, the status of mitigation actions implemented over the past three years was evaluated to ensure that the state is making progress with its mitigation strategy. Progress is measured based on the following variables:

- The number of projects implemented over time
- The successful disbursement of mitigation grant funds over time
- The disaster losses avoided over time (given a postdisaster event)
- Plans, partnerships, and outreach developed over time

The number of projects that incorporate mitigation while meeting other community objectives, such as a floodplain buyout project that becomes a community park and natural area, is another measure of success. These are the kinds of projects that gain community buy-in for mitigation and do not need a disaster to demonstrate tangible benefits. These types of success stories are discussed in Chapter 7 Enhanced Plan along with methods of promoting them.

Another measure of progress is the achievement of mitigation on a day-to-day basis through activities of the state. Missouri chose to measure this based on the Emergency Management Accreditation Program's (EMAP) mitigation standards (see Section 4.4 Mitigation Actions).

Actions that the state has been involved with between 2002 and 2006 are summarized in Table 4.12. The number of actions and amount of funds dispersed through various grant programs indicate that Missouri is making progress with implementation of its mitigation strategy. The high number of tornado safe room projects reflects the recent tornado disasters and the momentum being built by the successful implementation of these projects across the state, especially in the more rapidly developing areas where safe rooms are being incorporated into the design of new structures (e.g., schools).

Low water crossings are alternatives to bridges in Missouri; however, they are dangerous when drivers attempt to use them during floods. Projects to address these low water crossing dangers entail replacing the crossings with bridges designed to accommodate flood flows. This mitigates impacts on life safety, as lives have been lost when drivers attempted to negotiate low water crossings during floods. More details, including funding sources used, can be found in Section 7.5 Effective Use of Available Mitigation Funding and Appendix D Past Mitigation Projects.

Table 4.12. Summary of Mitigation Actions Implemented or Obligated, 2002–2006

Project Type	Action Category	Number of Projects	Funding Amount
Flood Buyouts	M3	27	$14,192,080
Flood Elevations	M4	1	$45,200
Tornado Safe Rooms	M5	22	$28,237,694
Bridge Replacements	M8	1	$449,787
Low Water Crossings	M8	2	$356,980
Streambank Stabilizations	M8	2	$132,315
Water Supply Interconnects	M8	1	$66,701
High Wind Retrofits	M6	1	$47,749
Buried Electric Lines	M9	4 (includes over 4,000 lines)	$7,649,298
State 5% Initiative Projects	M10	6	$236,640

Details on the above projects, including funding sources and general timeframe are provided in Table 4.13. This documentation indicates that Missouri is effectively using both pre- and postdisaster funding mechanisms and has been successful at securing annual allocations of mitigation funds in the nationally competitive Pre-Disaster Mitigation grant program. Since Missouri has an enhanced hazard mitigation plan, they receive 20 percent of postdisaster costs from the Hazard Mitigation Grant Program for mitigation purposes. Several project closeouts are also noted, indicating successful mitigation grant management. Section 6.2.1 Monitoring Implementation of Mitigation Measures and Project Closeouts provides details on individual project review and closeout procedures.

Table 4.13. Mitigation Project Summary Table 2002–2006

Hazard Mitigation Grant Program 2002	
Buried Lines	2
Buyouts	19
Safe Rooms	2
State 5% Initiative Projects	5
Total Projects	29
Number of Projects Closed/Completed*	19/9
Number of Projects Pending Closed/Completed*	0/0
Hazard Mitigation Grant Program 2003	
Buyouts	3
Water Lines	1
State 5% Initiative Projects	1
Total Projects	5
Number of Projects Closed/Completed*	0/4
Number of Projects Pending Closed/Completed*	1

Hazard Mitigation Grant Program 2004	
Safe Rooms	1
Total Projects	1
Number of Projects Closed/Completed*	1/0
Number of Projects Pending Closed/Completed*	0
Flood Mitigation Assistance FY04, FY05, and FY06	
Buyouts	3
Elevation	1
Total Projects	4
Number of Projects Closed/Completed*	0/2
Number of Projects Pending Closed/Completed*	2
Pre-Disaster Mitigation—Competitive FY 2004	
Safe Rooms	2
Total Projects	2
Number of Projects Closed/Completed*	1/1
Number of Projects Pending Closed/Completed*	0
Pre-Disaster Mitigation FY 2005	
Bank Stabilization	2
Bridge Replacement	1
Buried Lines	1
Buyouts	2
Low Water Crossings	2
Safe Rooms	13
Total Projects	21
Number of Projects Closed/Completed*	1/3
Number of Projects Pending Closed/Completed*	17
Pre-Disaster Mitigation FY 2006	
Buried Lines	1
Safe Rooms	4
Total Projects	5
Number of Projects Closed/Completed*	0/0
Number of Projects Pending Closed/Completed*	5

Note:
*Number of projects closed are projects in which the final performance is complete
Number of projects completed are projects in which all work is complete but the final performance report has not been approved
Number of projects pending closed/completed are projects that have not completed their scope of work
Source: State Emergency Management Agency

Prior to 2002, Missouri used mitigation funding for buyouts, elevations, and relocations; however, the nature of hazards in Missouri and types of mitigation projects broadened. Priority is still flood mitigation, but changes in threats have forced SEMA to broaden its perspective in mitigation projects. A list of mitigation projects dating back to 1993 can be found in Appendix D Past Mitigation Projects.

Progress in the remaining mitigation action categories, those not addressed in Table 4.12, are summarized below. These action categories are more program- than project-related.

M1—State and Local Hazard Mitigation Plans: Within the past three years, 82 percent of Missouri counties have successfully completed and received FEMA-approval for their hazard mitigation plans. As of February 2007, 94 of 115 Missouri counties (including St. Louis City), which altogether accounts for 94 percent of Missouri's population, had hazard mitigation plans that met the requirements of both the Disaster Mitigation Act of 2000 and the Flood Mitigation Assistance Program.

The implementation of local hazard mitigation plans through the assistance of the Regional Planning Commissions has been a major success story for Missouri's mitigation program. Not only are local communities more aware of what mitigation is and how it can benefit them, but the RPCs are more cognizant of integrating mitigation into other planning efforts, such as transportation and capital improvement plans. For more information, see Chapter 5: Coordination of Local Mitigation Planning.

M2—National Flood Insurance Program Floodplain Management and Community Rating System: Participation in the NFIP has increased between the publication of the 2004 plan and January 2007 (see Table 4.4). Eight communities from the emergency program have moved to the regular program and an additional 21 communities have joined the program. As of January 2007, there were 591 participating jurisdictions: 584 communities in the regular program and 7 communities in the emergency program. All the participating communities have established local floodplain management ordinances to help them administer the program. Mitigation planning and the Pre-Disaster Mitigation grant program have had a positive impact on NFIP interest and participation. The program is expected to continue to grow. Many communities have had their flood hazards newly mapped but have not yet joined the program.

Funds from a variety of programs have been used to develop flood maps for previously unmapped areas and to revise/update older existing maps. This initiative will enable more communities in the state to join the National Flood Insurance Program (NFIP). SEMA is participating in FEMA's Map Modernization program and in early 2007 was in the process of converting and/or updating flood maps in 39 counties.

M7—Earthquake/High Wind Nonstructural Mitigation Projects: No new projects were implemented between 2004 and 2007. Part of the reason for this is that there have been no recent earthquake events and that increased interest in tornado shelter projects has occurred due to recent tornado disasters.

M11—Technical Assistance: SEMA organized three Pre-Disaster Mitigation (PDM) grant mentoring workshops, one each for the 2005, 2006, and 2007 grant cycles, to help local governments develop PDM subgrant applications and benefit-cost analyses. The workshops assisted 40 local governments with their applications. The 2005 grant cycle workshop resulted in the success of 76 percent of the applicants.

Sections 7.4 Assessment of Mitigation Actions and 7.5 Effective Use of Mitigation Funding provide additional examples of the progress and success of mitigation actions and programs.

4.4.5 Review and Integration with Local Actions

A roll-up and analysis of the mitigation actions contained in local plans was conducted to summarize the types of mitigation actions most commonly implemented, or desired to be implemented, at the local level. This analysis includes a summary of the actions and the associated hazards, which gives an indication of the priority hazards to be mitigated at the local level.

Methodology

The roll-up was conducted by reviewing and capturing key elements of the mitigation sections of each local plan into a master spreadsheet. Most local plans provided a summary table of their mitigation actions, which included a variety of information, such as action description, category of mitigation action, priority, responsible agency, potential funding sources, hazard addressed, and the action's relationship to the local plan's goals and objectives. Some local plans provided a limited amount of information that made it difficult to summarize their data.

The roll-up of the local mitigation actions focused on evaluating the types of local mitigation actions by determining the following:

- The total number of mitigation actions in each county
- The number of actions for each mitigation category (i.e., prevention, emergency services, property protection, natural resource protection, structural protection, and public information)
- The types of hazards addressed by each mitigation action

Most of this information was included in the mitigation action summary tables of the local plans. Additional information was obtained, where necessary, in the local plans' text. In some instances, where the mitigation categories as defined by the local plan did not meet the six FEMA-established mitigation categories included in FEMA state and local guidance, the actions were assigned to the most suitable FEMA category. In summary,

- 36 plans classified their projects into the six FEMA mitigation categories,
- 30 plans classified their projects into other categories, in addition to the FEMA six,
- 31 plans had limited data or data in a format that did not lend itself to this roll-up, and
- Those local plans with FEMA mitigation categories identified also included information on the hazard(s) addressed by each action measure.

This analysis assumes that the action was accurately categorized in the FEMA categories, to the extent possible, in the local mitigation plan. There were instances where the action was not in the appropriate category, but no effort was made to try to reinterpret the information in the local plans. Some actions that are life safety oriented, such as tornado safe rooms, do not easily fit into any of the six categories. Most assigned this action to structural projects.

Results

Tables 4.14 and 4.15 summarize the results of the roll-up of local mitigation actions.

Table 4.14. Breakdown of Local Actions by Mitigation Categories

Mitigation Category	Percent
Emergency Services	23.0%
Prevention	19.7%
Public Information	19.7%
Property Protection	17.3%
Multi-Objective	13.9%
Natural Resources	3.5%
Structural Projects	2.6%
Other	0.5%

Table 4.15. Breakdown of Hazards Addressed by Local Actions

Hazard	Percent
Flood	16%
Tornadoes	14%
Severe Winter Weather	13%
Earthquakes	12%
Dam Failure	11%
Fire	11%
Heat Waves	10%
Drought	8%
Thunderstorms	3%
Other	2%

Based on this summary, it appears that local mitigation plans include actions that mitigate several hazards. Priority hazards are flooding, tornadoes, severe winter weather, and earthquakes. This is consistent with the local risk assessment roll-up in Section 3.3.1 Assessing Vulnerability by Jurisdiction. Many of the actions identified in the plans addressed multiple hazards.

In addition to the statistical information detailed above, several general observations were made with respect to the local mitigation action strategies. These include the following:

- All local plans summarized in this effort developed actions for all identified hazards.
- A large portion of the actions seemed to be policy and/or regulatory in nature. That is, they dealt with influencing change on the front-end through community outreach efforts, policy changes, and the development and enforcement of new regulations. Many of these fell into the prevention, public information, and emergency services categories.

4.4.6 Challenges in Implementation

In general, the state has been very successful in implementing mitigation projects. This is demonstrated in Section 7.2 Project Implementation Capability. Funding, or lack thereof, has been one challenge in implementing mitigation projects in Missouri. Missouri has taken advantage of new grant programs, such as the Pre-Disaster Mitigation program, which has annual allocations, to fund projects in between presidential disaster declarations. Missouri does experience presidential disasters frequently enough to obtain significant Hazard Mitigation Grant Program funds (this funding, in general, has been much less in recent years compared to what was available following the floods of 1993 and 1995). The fact that Missouri does regularly experience disasters presents its own special challenge, as SEMA mitigation staff are often involved in response and recovery operations in addition to mitigation program administration. Solutions to this challenge include developing innovative solutions for surge capacity backfill of SEMA mitigation staff if necessary. Currently this is accomplished through contracts. The grant program has increased from about $15 million to approximately $75 million.

4.4.7 Mitigation Success

Mitigation successes are discussed in detail in Section 7.5 Effective Use of Available Mitigation Funding.

4.5 Funding Sources

Requirement §201.4(c)(3)(iv):	[The state mitigation strategy shall include an] identification of current and potential sources of federal, state, local, or private funding to implement mitigation activities.

Missouri uses a variety of sources to fund state and local mitigation activities. While most of the funding is from the federal government, some also comes from state and local.

4.5.1 Primary Federal and State Funding

The state, through SEMA, has instituted an effective and comprehensive all-hazard mitigation program. Through the wise use of available federal and state funds, made available through a variety of programs (Hazard Mitigation Grant Program, Public Assistance, Federal Unmet Needs, Project Impact, Flood Mitigation Assistance, Pre-Disaster Mitigation, Community Development Block Grants, Department of Natural Resources Stormwater Grants, Natural Resources Conservation Service, and more), the state has been able to successfully mitigate many areas against the devastating effects of future disasters.

FEMA’s three main hazard mitigation programs are the primary sources of current funding for Missouri’s mitigation activities. These three programs are the Flood Mitigation Assistance

Program, Hazard Mitigation Grant Program, and Pre-Disaster Mitigation program. More detail on how this assistance was used since 2002 can be found in Section 4.4.4 Review and Progress of Mitigation Actions. Two newer FEMA programs, the Repetitive Flood Claims program and the Severe Repetitive Loss program, are potential funding sources for the future. All five of these programs are discussed further in the following pages.

Flood Mitigation Assistance Program

Program Summary:

The Flood Mitigation Assistance Program (FMA) is a program under FEMA's National Flood Insurance Program (NFIP). Its purpose is to implement cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program (NFIP). The FMA provides planning grants for communities to assess their flood risk and identify actions to reduce it. Planning grants may be used to develop a new or update an existing flood mitigation plan (this also applies to the flood hazard portion of multihazard mitigation plans).

Project grants are available for acquisition, structure demolition, or structure relocation with the property deed restricted for open space uses in perpetuity; elevation of structures; dry floodproofing of nonresidential structures; and minor structural flood control activities.

Planning grants are available for flood mitigation planning activities.

Amount:

For fiscal year 2007 (October 1, 2006-September 30, 2007), Congress appropriated $31 million for the FMA. Based on an allocation formula, each state will receive a base amount of $110,000. Surplus amounts will be distributed based on each state/territory's participation in the NFIP (number of policies and repetitive loss properties).

Eligibility:

In Missouri, SEMA serves as the applicant for all FMA grants. State-level agencies, federally recognized Indian tribal governments, and local governments (including state-recognized Indian tribes and authorized Indian tribal organizations) are eligible to apply to SEMA for assistance as subapplicants. Individuals and private nonprofit organizations are not eligible to apply to the state, but a relevant state agency or local community may apply on their behalf. SEMA reviews and prioritizes subapplications and submits the grant application with subapplications to FEMA for review and approval.

All subapplicants must be participating and in good standing in the NFIP.

For project grants, subapplicants must have a FEMA-approved flood mitigation plan or multi-hazard mitigation plan that meets FMA planning requirements. All activities submitted for

consideration must be consistent with the local mitigation plan as well as the Missouri State Hazard Mitigation Plan.

Cost-Share Requirements:

FMA funds are provided on a 75 percent federal/25 percent nonfederal cost share basis. The recipient must provide the 25 percent match, only half of which may be in-kind contributions. For severe repetitive loss properties, FEMA will contribute up to 90 percent of the total eligible costs if the state has taken actions to reduce the number of severe repetitive loss properties and has an approved state mitigation plan that specifies how it intends to reduce the number of severe repetitive loss properties.

Requirements:

Recipients of FMA planning grants must produce FEMA-approved flood mitigation plans.

More Information:

Flood Mitigation Assistance (FMA) Program
www.fema.gov/government/grant/fma/index.shtm

SEMA
(573) 526-9100
http://sema.dps.mo.gov/

FEMA Region VII
(816) 283-7063
www.fema.gov/about/contact/regionvii.shtm

SEMA Fund Administrator:

Logistics, Mitigation and Floodplain Management Branch, State Hazard Mitigation Officer

Hazard Mitigation Grant Program

Program Summary:

The Hazard Mitigation Grant Program (HMGP) is a FEMA program. Its purpose is to provide funds to states, territories, Indian tribal governments, and communities to significantly reduce or permanently eliminate future risk to lives and property from natural hazards. HMGP funds projects in accordance with priorities identified in state, tribal, or local hazard mitigation plans, and enables mitigation measures to be implemented during the recovery from a disaster.

HMGP funds can be used for projects to protect either public or private property, as long as the project fits within state and local government mitigation strategies to address areas of risk and complies with program guidelines. Examples of projects include acquiring and relocating structures from hazard-prone areas; retrofitting structures to protect them from floods, high

winds, earthquakes, or other natural hazards; constructing certain types of minor and localized flood control projects; and constructing safe rooms inside schools or other buildings in tornado-prone areas.

The state may set aside up to 7 percent of the HMGP funds received following a presidential disaster declaration to develop FEMA-approved mitigation plans. The state may also set aside up to 5 percent of the HMGP funds to be used to fund the State 5% Initiative Projects (see Section 4.4.1: Actions (Projects) That Will Be Considered by the State of Missouri).

Amount:

Federal funding under the HMGP is available following a major disaster declaration if requested by the governor. The amount of an HMGP grant will depend on the costs associated with each individual disaster. Since the Missouri State Hazard Mitigation Plan is an enhanced plan, the state is eligible for up to 20 percent of the total estimated federal assistance provided after a major disaster declaration. States with standard hazard mitigation plans are eligible for 15 percent for amounts not more than $2 billion, 10 percent for amounts of more than $2 billion and not more than $10 billion, and 7.5 percent on amounts more than $10 billion and not more than $35.3 billion.

Eligibility:

HMGP funds are administered by SEMA. Local governments, certain private nonprofit organizations or institutions, and Indian tribes or authorized tribal organizations are eligible to apply to SEMA for assistance as subapplicants. Individuals and businesses are not eligible to apply to the state, but eligible local governments or private nonprofit organizations may apply on their behalf. SEMA reviews and prioritizes subapplications and submits the grant application with subapplications to FEMA for review and approval.

For project grants, subapplicants must have a FEMA-approved local mitigation plan. All activities submitted for consideration must be consistent with the local mitigation plan as well as the Missouri State Hazard Mitigation Plan.

Cost-Share Requirements:

HMGP funds are provided on a 75 percent federal/25 percent nonfederal cost share basis. The nonfederal match does not does not need to be cash; in-kind services and/or materials may be used.

More Information:

Hazard Mitigation Grant Program
www.fema.gov/government/grant/hmgp/index.shtm

SEMA
(573) 526-9100
http://sema.dps.mo.gov/

FEMA Region VII
(816) 283-7969
www.fema.gov/about/contact/regionvii.shtm

SEMA Fund Administrator:

Logistics, Mitigation and Floodplain Management Branch, State Hazard Mitigation Officer

Pre-Disaster Mitigation Program

Program Summary:

The Pre-Disaster Mitigation (PDM) program is a FEMA grant program. Its purpose is to provide funds to states, territories, Indian tribal governments, and communities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations.

Project grants are available for voluntary acquisition of real property (i.e., structures and land, where necessary) for open space conversion; relocation of public or private structures; elevation of existing public or private structures to avoid flooding; structural and nonstructural retrofitting of existing public or private structures to meet/exceed applicable building codes; construction of safe rooms for public and private structures; vegetation management (e.g., for wildfire); protective measures for utilities, water and sanitary sewer systems, and infrastructure; storm water management projects; and localized flood control projects that are designed specifically to protect critical facilities and that do not constitute a section of a larger flood control system.

Planning grants are available for new plan development, plan upgrades, and comprehensive plan reviews and updates.

Amount:

For fiscal year 2007 (October 1, 2006-September 30, 2007), Congress appropriated $100 million for competitive grants, technical assistance, and program support. Each state will receive at least $500,000 for subapplication(s). The rest of the money will be awarded to subapplicants on a competitive basis (nationally). The proposed program budget for fiscal year 2008 is $100 million.

Eligibility:

In Missouri, SEMA serves as the applicant for all PDM grants. State-level agencies, including state institutions (e.g., state hospital or university); federally recognized Indian tribal

governments; local governments (including state recognized Indian tribes and authorized Indian tribal organizations); public colleges and universities; and Indian Tribal colleges and universities are eligible to apply to SEMA for assistance as subapplicants. Private nonprofit organizations and private colleges and universities are not eligible to apply to the state, but an eligible, relevant state agency or local government may apply on their behalf. SEMA reviews and prioritizes subapplications and submits the grant application with subapplications to FEMA for review and approval.

All subapplicants that have been identified through the NFIP as having a Special Flood Hazard Area and that have a Flood Hazard Boundary Map or a Flood Insurance Rate Map must be participating and in good standing in the NFIP.

For project grants, subapplicants must have a FEMA-approved local mitigation plan. All activities submitted for consideration must be consistent with the local mitigation plan as well as the Missouri State Hazard Mitigation Plan.

Cost-Share Requirements:

PDM grants are provided on a 75 percent federal/25 percent nonfederal cost share basis. Small and impoverished communities may be eligible for up to a 90 percent federal cost-share (see Section 5.3.3 Small and Impoverished Communities).

Requirements:

Recipients of PDM planning grants must produce FEMA-approved hazard mitigation plans.

More Information:

Pre-Disaster Mitigation Program
www.fema.gov/government/grant/pdm/index.shtm

SEMA
(573) 526-9100
http://sema.dps.mo.gov/

FEMA Region VII
(816) 283-7063
www.fema.gov/about/contact/regionvii.shtm

SEMA Fund Administrator:

Logistics, Mitigation and Floodplain Management Branch, State Hazard Mitigation Officer

Repetitive Flood Claims Program

Program Summary:

The Repetitive Flood Claims (RFC) program is a FEMA program. Its purpose is to reduce or eliminate the long-term risk of flood damage to structures insured under the National Flood Insurance Program (NFIP) that have had one or more claim payment(s) for flood damage.

Project grants are available for acquisition, structure demolition, or structure relocation with the property deed restricted for open-space uses in perpetuity.

Planning grants are not available.

Amount:

For fiscal year 2007(October 1, 2006-September 30, 2007), Congress appropriated $10 million for the RFC program. RFC grants are awarded nationally without reference to state allocations, quotas, or other formula-based allocation(s) of funds.

Eligibility

RFC funds can only be used mitigate structures that are located within a state or community that cannot meet the requirements of the FMA for either cost share or capacity to manage the activities.

In Missouri, SEMA serves as the applicant for all RFC grants. State-level agencies, federally recognized Indian tribal governments, and local governments (including state-recognized Indian tribes and authorized Indian tribal organizations) are eligible to apply to SEMA for assistance as subapplicants. Individuals and private nonprofit organizations are not eligible to apply to the state, but a relevant state agency or local community may apply on their behalf. SEMA reviews and prioritizes subapplications and submits the grant application with subapplications to FEMA for review and approval.

All subapplicants must be participating and in good standing in the NFIP.

Cost-Share Requirements:

All RFC grants are eligible for up to 100 percent federal assistance.

More Information:

Repetitive Flood Claims Program
www.fema.gov/government/grant/rfc/index.shtm

SEMA
(573) 526-9100
http://sema.dps.mo.gov/

FEMA Region VII
(816) 283-7063
www.fema.gov/about/contact/regionvii.shtm

SEMA Fund Administrator:

Logistics, Mitigation and Floodplain Management Branch, State Hazard Mitigation Officer

Severe Repetitive Loss Program

(Information is preliminary; guidance has not been released)

Program Summary:

The Severe Repetitive Loss (SRL) program is a FEMA program. Its purpose is to reduce or eliminate the long-term risk of flood damage to severe repetitive loss residential properties and the associated drain on the National Flood Insurance Fund (NFIF) from such properties. FEMA defines SRL properties as residential properties that have at least four NFIP claim payments over $5,000 each, at least two of which occurred within any ten-year period, and the cumulative amount of such claims payments exceeds $20,000; or that have at least two separate claims payments (building payments only) where the total of the payments exceeds the value of the property, when two such claims have occurred within any ten-year period.

Project grants are available for flood mitigation activities such as acquisition, structure demolition, or structure relocation with the property deed restricted for open-space uses in perpetuity; elevation of structures; floodproofing of structures; minor physical localized flood control projects; and demolition and rebuilding of structures.

Planning grants are not available.

Amount:

The SRL program is authorized for up to $40 million for each fiscal year 2005 through 2009.

Eligibility:

In Missouri, SEMA serves as the applicant for all SRL grants. State-level agencies, federally recognized Indian tribal governments, and local governments (including state-recognized Indian tribes and authorized Indian tribal organizations) are eligible to apply to SEMA for assistance as subapplicants. Individuals and private nonprofit organizations are not eligible to apply to the state, but a relevant state agency or local community may apply on their behalf. SEMA reviews and prioritizes subapplications and submits the grant application with subapplications to FEMA for review and approval.

All subapplicants must be participating and in good standing in the NFIP.

Cost-Share Requirements:

SRL grants are provided on a 75 percent federal/25 percent nonfederal cost share basis. Up to 90 percent federal cost-share funding may be available for projects approved in states, territories, and federally recognized Indian Tribes with FEMA-approved standard or enhanced mitigation plans or Indian tribal plans that include a strategy for mitigating existing and future SRL properties.

More Information:

Severe Repetitive Loss Program
www.fema.gov/government/grant/srl/index.shtm

SEMA
(573) 526-9100
http://sema.dps.mo.gov/

FEMA Region VII
(816) 283-7063
www.fema.gov/about/contact/regionvii.shtm

SEMA Fund Administrator:

Logistics, Mitigation and Floodplain Management Branch, State Hazard Mitigation Officer

Other Sources of Federal and State Funding and Technical Assistance

Additional sources of federal and state funding and technical assistance can be found in Appendix A Funding and Assistance Programs and are separated into the following categories:

- General emergency management grants, loans, and assistance
- Floods/flood control grants, loans, and technical assistance
- Earthquake grants, loans, and technical assistance
- All-hazard mapping grants, loans, and technical assistance
- Ancillary flood and natural resource projects grants, loans, and technical assistance;
- Basic and applied research/development grants
- Other planning resources: Demographics, societal data, and transportation, agricultural, Industrial, and economic statistics

4.5.2 Local Funding

Local governments receive most of their funding for mitigation projects from the federal programs discussed above. Sources of local funding include tax-funded investments (predominantly from property and sales tax) in infrastructure improvements and dedicated transportation/capital improvements sales or use taxes, all of which can also serve to mitigate hazards. A sales tax or bond issue to fund mitigation would require a vote of residents and could

be difficult to pass. More information about local funding can be found in Section 4.3.2 Local Policies, Programs, and Capabilities and Section 7.5 Effective Use of Available Mitigation Funding.

5.0 Coordination of Local Mitigation Planning

This chapter focuses on three aspects of the state's involvement in local mitigation planning:

- Local Funding and Technical Assistance
- Local Plan Integration
- Prioritizing Local Assistance

5.1 Local Funding and Technical Assistance

Requirement §201.4(c)(4)(i):	[The section on the coordination of local mitigation planning must include a] description of the state process to support, through funding and technical assistance, the development of local mitigation plans.

5.1.1 Background

Per the Disaster Mitigation Act of 2000, all local governments must have a hazard mitigation plan approved by the Federal Emergency Management Agency (FEMA) to receive project grants from the Hazard Mitigation Grant Program[1] and the Pre-Disaster Mitigation program. An approved flood mitigation plan (which may be part of an approved multihazard plan) is required for the Flood Mitigation Assistance Program. (The Repetitive Flood Claims and Severe Repetitive Loss programs do not currently require a local hazard mitigation plan). It is the role of the state to provide assistance to local governments for plan development and to ultimately use the local plans to improve the statewide plan.

When the Hazard Mitigation Planning Team prepared the 2004 version of the Missouri State Hazard Mitigation Plan, local mitigation plans were largely unavailable and local information was limited.

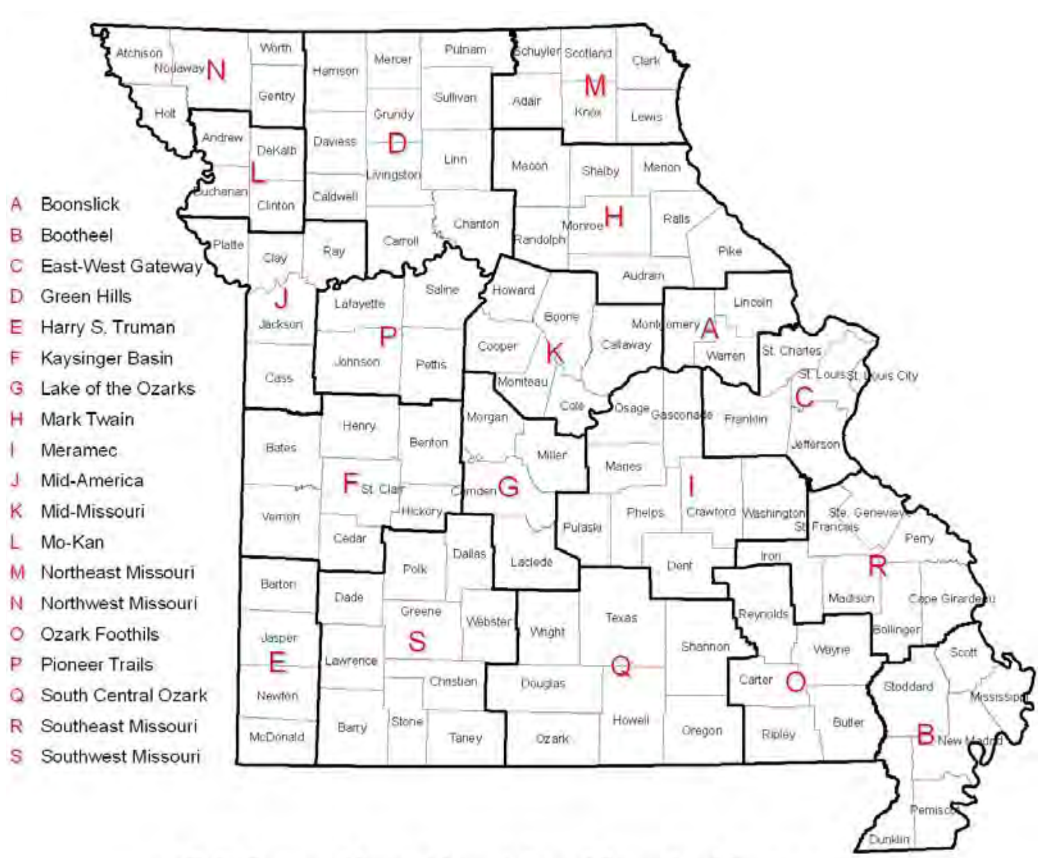
After a thorough review of all options, SEMA's Logistics, Mitigation and Floodplain Management Branch contacted the Missouri Association of Councils of Government, the umbrella organization for Missouri's 19 Regional Planning Commissions/Councils of Government (RPCs) (see Figure 5.1), for help with the development of multijurisdictional

[1] FEMA guidance allows the FEMA regional director to grant exceptions to this requirement in extraordinary circumstances, such as for small and impoverished communities. In these cases, a plan must be completed within 12 months of the award of the Hazard Mitigation Grant Program project grant. See Section 5.3.3 Small and Impoverished Communities for a discussion of these communities.

county-level plans. With guidance and prioritization (see Section 5.3 Prioritizing Local Assistance) from SEMA, RPCs were asked to develop mitigation plans for the counties in their region that would:

- Meet the requirements of the Disaster Mitigation Act of 2000 for local hazard mitigation plans;
- Include the unincorporated and incorporated parts of the county, regardless of population, and;
- Specifically address natural hazards and mitigation strategies and initiatives for each incorporated jurisdiction.

Figure 5.1. Missouri Regional Planning Councils



Data Source: Missouri Association of Councils of Government
Map Compilation: AMEC

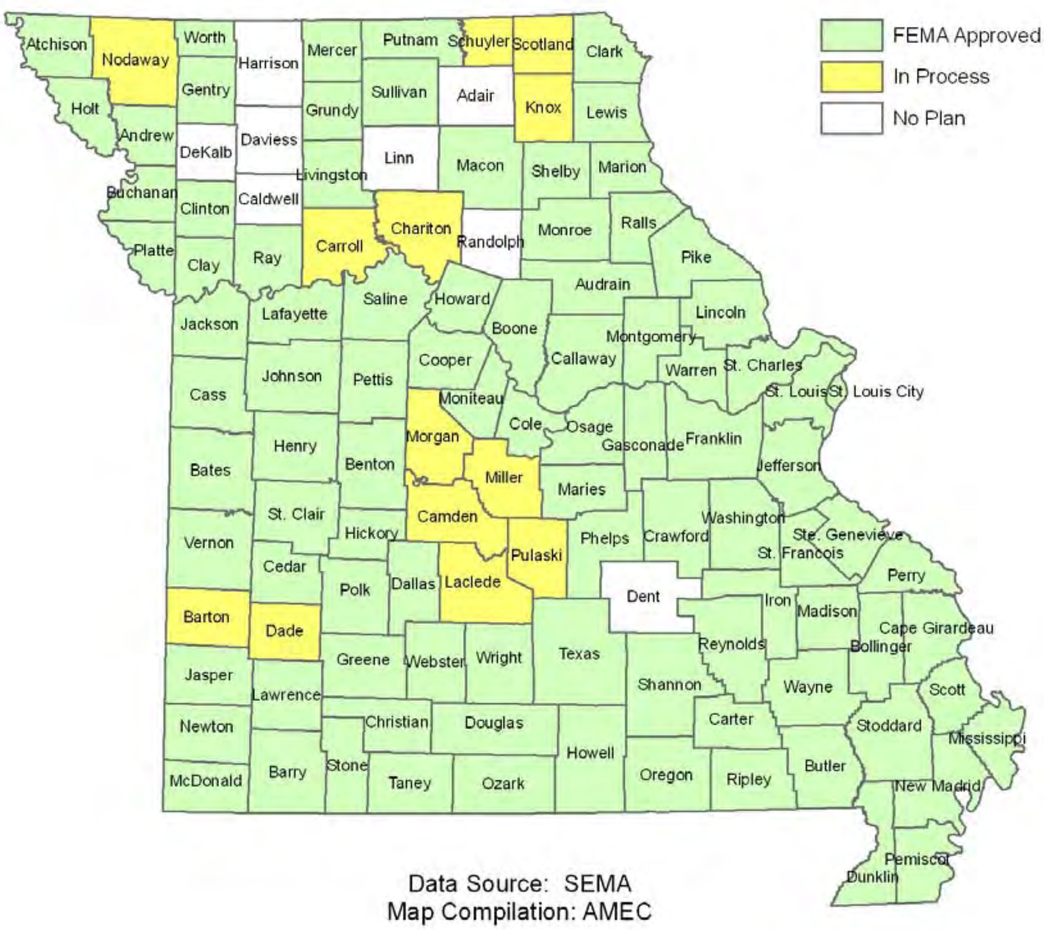
As a result of two presidentially declared disasters in 2002 (DR 1403 and DR 1412) and one in 2003 (DR 1463), SEMA had a limited amount of planning funds that they allocated to fund the RPCs' local hazard mitigation planning efforts. Counties that did not receive initial funding were provided with planning documents, guidance, and information from SEMA's Logistics, Mitigation and Floodplain Management Branch. As funding for planning becomes available, SEMA uses a list of questions to help prioritize how best to distribute it (see Section 5.3 Prioritizing Local Assistance).

With most of the county-level plans now available, SEMA can better coordinate its efforts with local jurisdictions and assess how to most effectively distribute project funding and technical assistance. This subsection describes the process the state uses to provide planning support to local jurisdictions and the types of funding and technical assistance they make available for initial and ongoing planning efforts.

5.1.2 Local Plan Development Status

Within the past three years, 82 percent of Missouri counties have successfully completed and received FEMA-approval for their hazard mitigation plans. As of February 2007, 94 of 115 Missouri counties (including St. Louis City), which altogether accounts for 94 percent of Missouri's population, had hazard mitigation plans that meet the requirements of both the Disaster Mitigation Act of 2000 and the Flood Mitigation Assistance Program (see Figure 5.2). Appendix E FEMA-Approved Local Hazard Mitigation Plans lists all of the jurisdictions in Missouri that are covered by a plan, their original approval dates, and their target update dates. Other jurisdictions included in the county-level plans that are not cities, towns, or villages include various public colleges along with several public school districts.

Figure 5.2. Local Mitigation Plan Status by County, January 2007



5.1.3 Process to Provide Local Assistance

Most jurisdictions require some form of assistance to develop and update their local hazard mitigation plans (FEMA requires that local plans be updated every five years, but plans may be updated more frequently if needed—e.g., after a major disaster). Since funding for planning purposes is generally minimal, and SEMA is unable to provide planning funds to every jurisdiction that requires a local hazard mitigation plan, technical support is the primary method that SEMA uses to provide planning assistance to local jurisdictions.

Although most Missouri counties now have FEMA-approved hazard mitigation plans, SEMA continues to work with the RPCs to provide assistance to those that do not. Most of the remaining counties are currently in the plan development stage or they have funding sources identified (e.g., Hazard Mitigation Grant Program, Pre-Disaster Mitigation program, local funds). Recent disaster declarations and the availability of postdisaster mitigation funds have provided further incentive to complete plans, since this money is not available to communities without approved plans.

Since local plans require updating every five years, SEMA anticipates focusing resources to the local plan update process in late 2007 and early 2008, pending FEMA's release of the local plan update guidance. To facilitate the update process, SEMA plans to continue working with the RPCs by providing FEMA update guidance and the new HAZUS-MH results for earthquakes and floods and hosting workshops. SEMA will also encourage local governments to apply for Pre-Disaster Mitigation planning grants. SEMA encourages participation in multijurisdictional plans and is considering how to handle jurisdictions that chose not to participate in their county-level plans but are now interested in developing plans.

In 2007, most of the local hazard mitigation plans were two years old or less. With the five-year update requirement for local plans, many updates will become due in 2010. SEMA will begin coordination with RPCs on the local update process in 2008, using additional staff hired for the purpose of coordinating local plans, to ensure that the local plan updates occur within the required timeframe.

5.1.4 Funding

There are two primary sources of funds available to help local jurisdictions develop and update hazard mitigation plans. These sources are FEMA's Hazard Mitigation Grant Program and Pre-Disaster Mitigation program. Detailed information about these programs is available in Section 4.5 Funding Sources.

Hazard Mitigation Grant Program

Planning Applicability:

Up to 7 percent of the Hazard Mitigation Grant Program (HMGP) funds set aside following a presidential disaster declaration may be used to develop FEMA-approved mitigation plans.

SEMA Fund Administrator:

Logistics, Mitigation and Floodplain Management Branch, State Hazard Mitigation Officer

Missouri Local Hazard Mitigation Grant Program Planning Distributions:

$1,081,120 in HMGP funds received by Missouri in 2002 and 2003 following presidential disaster declarations DR 1403, DR 1412, and DR 1463 were used to fund development of local mitigation plans. State matching funds totaled $303,134 and local matching funds totaled $56,884.

Pre-Disaster Mitigation Program

Planning Applicability:

Pre-Disaster Mitigation (PDM) grants can be used for mitigation plan development, upgrades, and comprehensive reviews and updates. Recipients of PDM planning grants must produce FEMA-approved hazard mitigation plans.

SEMA Fund Administrator:

Logistics, Mitigation and Floodplain Management Branch, State Hazard Mitigation Officer

Missouri Local Pre-Disaster Mitigation Program Planning Distributions:

$534,106 in PDM funds received by Missouri for PDM years 2002, 2003, and 2004 were used to fund development of local mitigation plans. Local matching funds totaled $181,194.

5.1.5 Technical Support

SEMA provides technical planning support to local jurisdictions through the Mitigation Section of the Logistics, Mitigation and Floodplain Management Branch. As discussed in Section 5.1.3 Process to Provide Local Assistance, SEMA contracted with the RPCs and provided them with guidance written by the state hazard mitigation officer to develop mitigation plans for the local governments in their regions. As discussed in Section 5.1.3, SEMA will provide new FEMA guidance and hold workshops to facilitate the five-year local plan updates.

SEMA continues to provide support to the RPCs, as well as directly to local governments, for new and updated plans. Each year, SEMA’s Mitigation Section offers FEMA G-318, Mitigation Planning Workshop for Local Governments. In addition, the section provides program specific information related to federal/state mitigation policy, state mitigation priorities, program administration, funding sources, and project eligibility requirements.

This state plan update is yet another form of technical support. The updated risk assessment as well as the HAZUS-MH earthquake and flood files, which are now available down to the county level, will be available to help locals assess/reassess their risk. The HAZUS-MH files will give local jurisdictions a more detailed understanding of their earthquake and flood risk. DVDs have

been created that contain the HAZUS-MH project files organized by RPC. These DVDs will be distributed to each RPC by SEMA by the end of 2007. The RPC will then distribute the DVDs to local jurisdictions for reference during the update of local plans.

5.2 Local Plan Integration

Requirement §201.4(c)(4)(ii):	[The section on the coordination of local mitigation planning must include a] description of the state process and timeframe by which the local plans will be reviewed, coordinated, and linked to the state mitigation plan.
Update §201.4(d):	[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities.

5.2.1 Review and Approval of Local Plans

The Disaster Mitigation Act of 2000 (Section 322(b)) calls for each local plan to "describe actions to mitigate hazards, risks, and vulnerabilities identified under the plan and establish a strategy to implement those actions." FEMA expanded on these basic criteria and established specific requirements for local mitigation plans. SEMA's hazard mitigation plan guidance dictates that all local hazard mitigation plans be developed to meet all federal requirements, address the specific hazard mitigation needs of the applicable jurisdictions, and complement the Missouri State Hazard Mitigation Plan. The state plan is used as a reference for locals to refer to in plan development. To ensure that local hazard mitigation plans meet these established criteria, SEMA works closely with the RPCs and local jurisdictions.

During development, local hazard mitigation plans undergo a continuous review that involves state and local officials and concerned members of the applicable communities. This helps to ensure that plan development moves along smoothly and that the plan is acceptable to the jurisdiction, its citizens, and the state. In 2004, SEMA reviewed all of the local plans before sending them on to FEMA. Since then, SEMA has been contracting the reviews out to one of the RPCs. SEMA's process for local plan review and approval is as follows:

1) SEMA contracts with the reviewing RPC to review the plan.
2) The submitting RPC submits the plan to SEMA.
3) SEMA sends the plan to the reviewing RPC.
4) The reviewing RPC works with the submitting RPC to resolve any concerns, as necessary.
5) Prior to adoption, the submitting RPC submits a revised draft to SEMA.
6) SEMA sends the draft to FEMA Region VII for conditional approval.
7) FEMA notifies SEMA of conditional approval.
8) SEMA notifies the submitting RPC of conditional approval.

9) The jurisdictions adopt the plan.
10) The submitting RPC sends the adopted plan with the resolutions to SEMA.
11) SEMA sends an electronic copy of the adopted plan with the resolutions to FEMA Region VII.
12) FEMA grants final approval (this determines the date of approval).
13) SEMA notifies the submitting RPC of final approval with a letter.

SEMA encourages the reviewing RPCs to review the plans and turn them around as quickly as possible. Currently, SEMA asks RPCs to review and provide feedback on a plan within three weeks of receipt (this does not include the time it may take to go back and forth with the submitting RPC). SEMA's goal is to have the 13 county plans that were still in-process during the 2007 update completed and approved in 2008. The goal for the remaining eight counties without plans is to have them completed in 2009.

Local mitigation projects and initiatives are based on the goals and objectives of local plans. However, it is understood that funding, situations, and priorities change. SEMA and FEMA allow jurisdictions the flexibility to add/subtract mitigation projects as priorities, funding, and situations change.

The process for plan updates will be the same as stated here for original plan development. Changes may be made if needed to comply with FEMA's guidance for local plan updates.

5.2.2 Linking Local Plans with the State Plan

The process of integrating state and local mitigation planning began with state staff involvement and guidance in the local planning process. It is understood by all levels of government that the success of the Missouri mitigation program depends on the degree to which everyone works together toward the common goal of reducing future disaster losses in Missouri. This is accomplished by involving as many interested groups and individuals as possible in the planning process. State mitigation staff meet with the RPCs and jurisdictions as needed throughout the planning process. While there is no specific schedule for these meetings, they occur:

- During scheduled public meetings,
- At the start of the planning process,
- At the mid-point of plan completion,
- At plan completion, and
- As requested by the RPC and/or affected jurisdiction.

It is also widely acknowledged that the local plans can benefit from data in the state plan, and the state plan can benefit from data in local plans. For this plan update, the Hazard Mitigation Planning Team reviewed and summarized information from the local plans. This information included:

- Hazard identification and risk assessment
- Goals and objectives
- Local capabilities
- Mitigation initiatives

The process in 2007 involved reviewing all of the county-level plans and capturing the information related to the four categories above in spreadsheets for further review and comparison purposes. (For more details on this process, and how the information was collected and incorporated, see Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction, Section 4.1 Hazard Mitigation Goals and Objectives, Section 4.3 Local Capability Assessment, and Section 4.4 Mitigation Actions.) This information was used to reassess state hazard and capabilities priorities and the progress in statewide mitigation efforts. Specifically, SEMA is interested in:

- Adding initiatives that proved successful at the local level,
- Researching development of mitigation initiatives that address local concerns,
- Reviewing state initiatives to determine if they are meeting the overall mitigation needs of the state, and
- Changing or eliminating mitigation initiatives that have not produced anticipated results.

As of 2007, this plan is now linked to all the existing county-level mitigation plans that cover 82 percent of the counties in the state. New and updated plans will be incorporated into the state plan during the next three-year update cycle, in 2010. By 2010, this plan should be linked to all the county mitigation plans. Should state priorities change, these plans may be incorporated sooner.

5.2.3 Successes and Challenges in Integration

This 2007 update reflects the successful integration of 82 percent of the county-level plans, which equates to coverage for 94 percent of Missouri’s population. Since Missouri has 115 counties (including St. Louis City) and 948 incorporated cities, towns, and villages, SEMA was challenged with how to effectively and efficiently develop plans for each of the jurisdictions. SEMA streamlined the process by encouraging local governments to participate in multijurisdictional county-level plans, which cut down on the number of plans that needed to be reviewed and integrated and brings communities together to focus on mitigation. SEMA is in the process of obtaining budget to hire a new mitigation planner in mid-2007 to work with local plans on a regular basis.

By providing local mitigation planning guidance detailing form and content requirements, SEMA had hoped to further streamline the integration of local plan data into the state plan. While it did prove to be a successful tool (as evidenced by the high number of plans approved), local risk assessments used different methods and interpretations to determine vulnerability and different measures to assess risk. Therefore, it was challenging to compare the counties to see

where one might be more vulnerable to a particular hazard than another. (More information about local plan integration can be found in Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction, Section 4.1 Hazard Mitigation Goals and Objectives, Section 4.3 Local Capability Assessment, and Section 4.4 Mitigation Actions.)

5.3 Prioritizing Local Assistance

Requirement §201.4(c)(4)(iii):	[The section on the coordination of local mitigation planning must include] criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs which should include: • Consideration for communities with the highest risks, • Repetitive loss properties, and • Most intense development pressures. Further that for non-planning grants, a principal criterion for prioritizing grants shall be the extent to which benefits are maximized according to a cost benefit review of proposed projects and their associated costs.
Update §201.4(d):	[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities.

This section describes the criteria the state uses to prioritize distribution of planning and project grants to communities and local jurisdictions. The criteria and process remain the same as indicated in the 2004 plan.

5.3.1 Planning Grants

Federal and state funding for mitigation planning is limited and in some instances is not available. The Flood Mitigation Assistance Program, Hazard Mitigation Grant Program, and Pre-Disaster Mitigation program are the primary sources of funding for mitigation planning. In the past, funding to meet the nonfederal match requirement of these grants came from Missouri's general revenue and local sources (cash and in-kind). Future nonfederal matches will need to come primarily from local sources; state general revenue will no longer be available.

There are always more requests for financial assistance for mitigation planning funds than there are funds available. Provision of funds for mitigation planning is based primarily on the availability of funds and whether the requesting jurisdiction has demonstrated the desire and ability to complete their plan as well as to follow through with the initiatives developed in the plan (which should not be dependent on the availability of state or federal funds).

As a result of two presidentially declared disasters in 2002 (DR 1403 and DR 1412) and one in 2003 (DR 1463), SEMA had a limited amount of planning funds available. The decision was made to use these funds to help meet the local hazard mitigation planning requirement. Since these funds were not sufficient to develop all of the required plans, SEMA developed criteria to select counties for funding in every region of the state: relationship to major rivers, population, number of federal disaster declarations (past 25 years), participation in the National Flood Insurance Program, and past mitigation funding.

Over time, SEMA developed a more sophisticated method of prioritizing funding. SEMA now uses the following list of questions to help guide the distribution of mitigation planning funds:

- Does the community meet the criteria for the applicable grant program (FMA, HMGP, PDM)?
- Based on the state and local risk assessment, what is the susceptibility of the community to natural and manmade disasters?
- Based on presidential disaster declarations, how many times has the community experienced disasters and what was the resulting damage (community infrastructure as well as families and businesses)?
- How many disasters that did not receive presidential declarations affected the community and what was the resulting damage (community infrastructure as well as families and businesses)?
- Does the community participate in the National Flood Insurance Program? If so, how many insured, repetitive loss structures are in the community?
- Is the community a small and impoverished community[2] or does it have special developmental pressures?
- Based on previous grant experiences (such as disaster grants, mitigation projects, other grants, etc.) what is the community's record of successful performance?
- Based on previous grant experiences with other state agencies (e.g., the Department of Economic Development Community Development Block Grant program) and the community's Regional Planning Commission/Council of Government, what is the community's record of successful performance?
- Has the community demonstrated the ability to form effective public-private hazard mitigation partnerships?

5.3.2 Project Grants

Federal and state funding for mitigation projects is also limited due to funding constraints, so the state has to prioritize proposed local mitigation projects. The Flood Mitigation Assistance Program, Hazard Mitigation Grant Program, and Pre-Disaster Mitigation program are the

[2] See Section 5.3.3 Small and Impoverished Communities for a discussion of these communities.

primary sources of funding for mitigation projects. The Repetitive Loss Flood Claims and Severe Repetitive Loss programs could become new sources of funding for repetitive-loss mitigation. Funding to meet the nonfederal match requirement of these grants comes mostly from U.S. Department of Housing and Human Development Community Development Block Grants and Missouri's general revenue. As state general revenue is no longer available, matching funds will have to come primarily from local sources going forward. Ideally, all communities will participate in some form of mitigation; however, due to differences in local capabilities and priorities, including the status of local mitigation plans, the degree of participation varies greatly from community to community.

In evaluating mitigation projects that have been submitted for review and possible approval, SEMA considers several factors, which include, but are not limited to, the following:

- The specific requirements and/or restrictions placed on the projects by the funding source.
- There will always be more requests for mitigation funds than there will be available funds.
- Federal and state funding for mitigation projects will be limited and in some instances may not be available.
- Whenever possible, local jurisdictions should develop mitigation projects and initiatives that can be funded locally.
- Local jurisdictions should actively pursue public-private partnerships, where appropriate, to achieve desired mitigation goals.
- The requested mitigation project should complement the goals and objectives of the state and local mitigation strategy.

When determining which communities will receive project grants, SEMA considers the basic criteria for assistance awards established by the Disaster Mitigation Act of 2000 (Section 203(g)):

- The extent and nature of the hazards to be mitigated;
- The degree of commitment of the local government to reduce damages from future natural disasters;
- The degree of commitment of the local government to support the hazard mitigation measures to be carried out using the technical and financial assistance;
- The extent to which the hazard mitigation measures to be carried out using the technical and financial assistance contribute to established state/local mitigation goals and priorities;
- The extent to which prioritized, cost-effective mitigation activities that produce meaningful and definable outcomes are clearly identified;
- The extent to which the activities above are consistent with the local mitigation plan;
- The opportunity to fund activities that maximize net benefits to society; and
- The extent to which assistance will fund activities in small and impoverished communities.[3]

[3] See Section 5.3.3 Small and Impoverished Communities for a discussion of these communities.

Missouri's project priorities consider hazards, vulnerability, and capabilities. Flood buyout projects (especially for repetitive loss properties) and other flood mitigation and structural projects to protect essential infrastructure are the state's highest priority. Projects to protect individuals from tornadoes and high wind rank second, followed by projects to reduce losses from earthquakes.

Specifically, SEMA uses the following list of questions to help guide the distribution of mitigation project funds:

- What is the hazard to be mitigated?
- Does the applicant have a FEMA-approved mitigation plan?[4]
- Does the project complement state and local mitigation goals and objectives identified in the mitigation plans?[5]
- Is the hazard being mitigated a priority hazard in the applicant's mitigation plan?
- Is the project cost-effective based on FEMA's benefit-cost analysis module?
- Does the project have the potential to substantially reduce the risk of future damage, hardship, loss, or suffering that may result from a major disaster?
- In the past, what mitigation efforts were undertaken by the applicant using local funds and initiatives and what were the outcomes?
- What is the applicant's disaster history?
- Are sufficient mitigation funds available to complete the project?
- Does the applicant have sufficient funds (if other funds are not available) to meet the local share of the project?
- Does the applicant have the capabilities to complete the project as submitted?
- Does the project independently solve a problem?
- Does the project have the potential to have a larger impact on the local and state mitigation program than other submitted projects?
- Does the project have any negative impacts on neighboring communities?

When the funding comes from the Hazard Mitigation Grant Program (postdisaster funding), priority is given to mitigation projects related to the hazard that necessitated the disaster declaration and those jurisdictions included in the disaster declaration.

Additional information about the process SEMA uses to evaluate and prioritize mitigation actions and determine cost-effectiveness is available in Section 7.2.1 Process Used to Evaluate and Prioritize Mitigation Actions, Section 7.2.2 Eligibility Criteria for Multihazard Mitigation

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[4] See Section 5.3.3.

[5] Since situations and priorities change over time, projects that are not in an applicant's mitigation plan may still be approved as long as they meet all other eligibility requirements.

Projects, Section 7.2.3 Eligibility Criteria by Mitigation Project Type, and Section 7.2.4 Cost-Effectiveness of Mitigation Measures.

5.3.3 Small and Impoverished Communities

44 CFR 201.2 establishes the following definition for small and impoverished communities:

"Small and impoverished communities means a community of 3,000 or fewer individuals that is identified by the state as a rural community, and is not a remote area within the corporate boundaries of a larger city; is economically disadvantaged, by having an average per capita annual income of residents not exceeding 80 percent of national, per capita income, based on best available data; the local unemployment rate exceeds by one percentage point or more, the most recently reported, average yearly national unemployment rate; and any other factors identified in the state plan in which the community is located."

Hazard Mitigation Grant Program

In regard to the plan requirement for Hazard Mitigation Grant Program project funds, FEMA regional directors may waive this requirement for small and impoverished communities. In these cases, a plan must be completed within 12 months of the award of the project grant.

Pre-Disaster Mitigation Grant Program

Small and impoverished communities that receive grants from the Pre-Disaster Mitigation program may receive a federal cost share of up to 90 percent of the total amount approved under the grant award (as opposed to the typical 75 percent federal cost share). Documentation must be submitted with the subapplication to support the eligibility for the higher cost share.

6.0 Plan Maintenance Process

This chapter focuses on two aspects of the state's involvement in the plan maintenance process:

- Monitoring, evaluating, and updating the plan
- Monitoring progress of mitigation activities

Also included in this chapter is a description of state agency responsibilities and staffing duties as they relate to the plan maintenance process, including the process for monitoring progress of mitigation activities.

6.1 Monitoring, Evaluating, and Updating the Plan

Requirement §201.4(c)(5)(i):	[The standard state plan maintenance process must include an] established method and schedule for monitoring, evaluating, and updating the plan.

The current Missouri State Hazard Mitigation Plan is the result of the combined efforts of the Hazard Mitigation Planning Team (HMPT), SEMA, Federal Emergency Management Agency (FEMA), Natural Resources Conservation Service, U.S. Army Corps of Engineers, National Weather Service, all nineteen (19) Regional Planning Commissions and/or Councils of Government in the state, local governments, electric cooperatives throughout the state, concerned citizens, and others.

Hazard mitigation planning is a continuous and ongoing process. Policies and procedures established in this plan reflect the current emergency management and hazard mitigation philosophy at both the state and national level. Changes in hazard mitigation programs and/or priorities, including changes in legislation and available funding, may necessitate modifications to this plan. A major disaster could also necessitate modifications to this plan.

6.1.1 Plan Maintenance Process

The Mitigation Section of the Logistics, Mitigation and Floodplain Management Branch within SEMA is the lead group responsible for developing, monitoring, and updating the Missouri State Hazard Mitigation Plan. Meetings of the HMPT are scheduled by the Mitigation Section as needed to review and update the plan. These meetings are to be conducted at a minimum:

- In the event of a major disaster and/or upon receiving a presidential disaster declaration, if needed/warranted;
- As part of the state's hazard mitigation plan review/update every three years; and

- When required/needed due to changes in federal/state regulations and/or legislation that impact the hazard mitigation program

In addition to these plan updates, SEMA conducts an in-house review and update conducted annually in order to assess plan status on a more regular basis. This review, done in conjunction with the development of SEMA's annual report, continues to allow the state to direct its priorities in the appropriate manner prior to disasters.

The following SEMA branches and other state agencies and departments participate in the development, review, and update of the state plan:

- SEMA's Logistics, Mitigation and Floodplain Management Branch
- SEMA's Planning and Disaster Recovery Branch
- Members of the HMPT
- Other SEMA branches and/or state agencies and departments that may be asked to assist in the review of this plan based on legislative changes, FEMA policy changes, or state priorities affecting the state hazard mitigation program

Representatives from the various agencies and departments on the HMPT are responsible for reviewing the plan and providing input and suggested changes based on the mitigation initiatives being undertaken by their respective organizations.

During updates, state agencies:

- Review hazard mitigation projects and initiatives to ensure there are no potential conflicts with ongoing agency initiatives,
- Review hazard mitigation projects and initiatives to ensure they complement the statewide mitigation strategy, and
- Review existing state/federal programs to ensure that the state is taking full advantage of possible funding sources in its implementation of the state hazard mitigation program.

A review of plan goals and objectives is also emphasized as part of the regular plan review process as well as in conjunction with the review/approval process of local hazard mitigation plans. This helps to ensure that the state and local hazard mitigation plans complement each other and that both state and local governments are working together to accomplish Missouri's mitigation goals. Additionally, proposed mitigation projects are reviewed to determine how they help state and local governments meet their established goals and objectives.

Plan maintenance implies an ongoing effort to monitor and evaluate plan implementation and to update the plan as progress, roadblocks, or changing circumstances are recognized. Evaluation of progress can further be achieved by monitoring changes in vulnerabilities identified in the plan.

Public involvement in the hazard mitigation process is accomplished through open public meetings as part of the development and review of local hazard mitigation plans. This process

began when the Regional Planning Commissions got involved with local mitigation planning meetings in 2004. State and local representatives participated in these meetings and public input was sought and taken into consideration in developing mitigation priorities.

2007 Plan Update

For this update to the Missouri State Hazard Mitigation Plan, the previously approved plan maintenance process was followed and evaluated. The HMPT determined that the elements and processes originally proposed to monitor, evaluate, and update the plan were effective. Additions to this process include the following considerations:

- Have there been changes in vulnerability due to project implementation?
- Are there success stories where mitigation efforts have proven effective?
- Are there new hazards that may be of concern?
- Are new data or studies on hazards and risks available?
- Are there new capabilities or changes in capabilities?
- Have there been any growth and development-related changes to county inventories?
- Are existing goals and objectives still applicable and are there any new goals and objectives?
- Are there new mitigation strategies or changes in project prioritization?
- How effective have the mitigation projects in place been?

Interim plan update meetings were held in accordance with the process detailed above. As a result of these meetings, three interim changes were made to the plan and additional recommendations were developed for inclusion in the 2007 plan update. The interim changes, which were approved by FEMA, were elaborations on the mitigation strategy, the detrimental impacts of hazards profiled in the plan, and the vulnerability of state facilities.

6.2 Monitoring Progress of Mitigation Activities

Requirement §201.4(c)(5)(ii) and (iii):	[The standard state plan maintenance process must include a] system for monitoring implementation of mitigation measures and project closeouts. [The standard state plan maintenance process must include a] system for reviewing progress on achieving goals as well as activities and projects in the mitigation strategy.

6.2.1 Monitoring Implementation of Mitigation Measures and Project Closeouts

As part of the plan maintenance process, the state has established a monitoring system for tracking the implementation and closeout of mitigation actions. This section includes a description of the current state monitoring system and modifications to the system identified during the 2007 plan update.

Mitigation Measures Monitoring System

The following paragraphs detail how the state tracks the implementation of mitigation actions and project closeouts.

Project Management

Upon notification from FEMA that a project has been approved and is eligible for funding, the state hazard mitigation officer (SHMO) notifies the subgrantee and arranges a meeting to provide the subgrantee with appropriate information on the grant program requirements, state policy, and grant management in accordance with 44 CFR 13. Materials provided to the subgrantee include:

- A Local Officials Guide to Managing a Voluntary Buyout (for buyout projects),
- 44 CFR 13 and 14, and
- OMB Circulars A-87 and A-102.

SEMA is the grantee for project management and accountability of funds for all FEMA grants in accordance with 44 CFR 13. Approved applicants are considered subgrantees and as such are accountable to the grantee for funds awarded to them.

Technical Assistance and Project Monitoring

SEMA (as grantee) recognizes the responsibilities laid out in 44 CFR 206.438(a): The state, serving as grantee, has primary responsibility for project management and accountability of funds as indicated in 44 CFR 13. The state is responsible for ensuring that subgrantees meet all program and administrative requirements.

SEMA is committed to monitoring and providing technical assistance to all eligible and funded subgrantees. The SHMO, project manager, and/or technical support staff attend subgrantee meetings to ensure the policies and procedures are explained correctly. Numerous worksheets, financial forms, and targeted guidebooks for local officials (e.g., the Mitigation Planning Workshop for Local Governments; Regional Planning Commission Hazard Mitigation Planning Guide 2002, and the All-Hazard Mitigation Planning Guidebook for Communities) have been developed by SEMA and have proven successful.

To track mitigation projects from initiation to closeout, a project tracking spreadsheet is used that includes the following information:

- Subgrantee name
- Project name
- Grant amount
- Percent expended
- Percent completed
- Grant end date
- Completion description (by project task and percent complete)

A system to track percent completed has been developed that is tied to steps associated with specific project types. Table 6.1 shows an example for a buyout project.

Table 6.1. Project Tracking System—Buyout Example

Buyout	Percent Complete of the Project
Buyout Policy	10%
Voluntary Agreements	20%
Appraisals Contracted	30%
Appraisals Completed	40%
Title Search Completed	50%
Properties Closed	60%
Asbestos Determination	70%
Demolition Contracted	80%
Demolition Completed	90%
Final Invoices Paid	100%

When necessary, a mitigation team member attends the first closing of a buyout project to offer assistance in completing the necessary FEMA forms (e.g., Voluntary/ Uniform Relocation Act, Duplication of Benefits, Closing Statement).

Site visits, telephone conversations, and facsimiles remain the best communication tools for the buyout program and any other mitigation project. Past mitigation successes reflect this; thus, SEMA is confident these mechanisms ensure subgrantees success in administering the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) program within federal and state regulations and policies. SEMA requires monthly progress reports (instead of quarterly) from subgrantees so that issues with implementation can be identified and handled in a timely manner.

A modified Standard Form 270, Request for Advance or Reimbursement, is used by SEMA for processing fund requests. General principles for processing Request for Funds (RFF) forms are as follows:

1) Verify RFF is original (no facsimiles) and signed by authorized signor
2) Verify spreadsheet “program allocated” and “administration allocated” columns are correct for the subgrantee
3) Verify the “current draw” columns are correct
4) Check for mathematical accuracy on the RFF
5) Check for supporting documentation (property list, invoices, equipment and materials costs, etc.)
6) Verify all properties requested to be funded have Duplication of Benefits released and State Historic Preservation Office clearance
7) Enter amounts requested on spreadsheet
8) Forward to Financial Department for processing
9) Copy all documents to project file

As a general rule, only 50 percent of administrative funds are released prior to project closeout.

Cost Overruns

For purposes of the mitigation buyout program, cost overruns are defined as additional funds necessary to complete a mitigation project defined in the original HMGP or PDM application submitted to FEMA for funding. Cost estimates for mitigation projects, such as acquisition and demolition, for individual structure/lots can be somewhat dynamic. (Note: Property closings resulting in an overrun that can be offset by property closings resulting in a net underrun are not considered cost overruns for this purpose and do not need FEMA approval as outlined in 44 CFR 206.438(b)).

For acquisition projects, any properties added to the property list after initial submission to FEMA require SEMA and FEMA approval. If add-on properties can be acquired with original grant allocations this is not considered an overrun. Adjustments to budget line items based on the HMGP Buyout Application do not need SEMA approval.

Immediately upon recognition that an original scope of work that has been approved and funded cannot be accomplished with the grant funds allocated, the grant administrator, through the authorized representative of the subgrantee, must submit a request for additional funds with appropriate justification documents to the governor’s authorized representative (GAR).

Upon receipt, the GAR reviews the documents and makes a determination. If the request is justifiable, the GAR forwards the request with the state’s recommendation to the FEMA regional director. If the request is not justifiable, the GAR denies the request. In no case will the total amount obligated to the state exceed the funding limits set forth in 44 CFR 206.432(b).

Appeals

All subgrantee appeals to FEMA decisions are administered in accordance with 44 CFR 206.440.

Quarterly Reports

Quarterly reports based on a calendar year are provided to the FEMA Region VII director as required by 44 CFR 206.438(c).

Environmental, Historic, and Floodplain Management Reviews

SEMA generally refers any needs for environmental reviews or environmental impact statements to the Missouri Department of Transportation (MoDOT):

1) SEMA mitigation staff provides the necessary project information to MoDOT.
2) MoDOT completes the necessary reports for SEMA based on an established memorandum of understanding.
3) SEMA then forwards the report to FEMA for review and approval.

Endangered species reviews are forwarded to the Department of Conservation.

The Missouri Floodplain Management Program was transferred to SEMA from the Department of Natural Resources on January 1, 1995. This transfer provides SEMA's hazard mitigation section a direct link with the department's State Historic Preservation Office (SHPO) as well as trained floodplain managers and engineers.

All mitigation projects, including projects funded to remove structures from floodplains, are forwarded to SEMA's Floodplain Management Section for review and comment. After a subgrantee has completed a buyout project and the grant is closed, a list of properties acquired is provided to the Floodplain Management Section for use when conducting community assistance visits with FEMA's Mitigation Division.

General Compliance Assurance Statement

Because of inherent limitations in any grant management program, errors may occur; however, as referenced throughout this plan, it is SEMA's intent to comply with all administrative requirements outlined in 44 CFR 13 and 206 and to monitor all subgrant supported activities to ensure compliance with 44 CFR 13 and 206.

Project Closeout

Upon completion of a hazard mitigation grant project, the program manager and/or hazard mitigation grant auditor conducts a closeout site visit to review all files (or a representative sample) and all documents pertaining to the use of HMGP, PDM, and state general revenue funds. In addition, all procurement files and contracts to third parties are reviewed. Worksheets have been created to aid in the closeout review.

All reports generated at the closeout site visit are compared with Request for Funds submitted throughout the duration of the program. Any significant findings are reported to the SHMO for final determination in corrective action. If necessary, Corrective Action notices are sent to subgrantees, and another site visit may be conducted prior to the release of remaining administrative funds.

Closeout reports are submitted for each subgrantee upon expiration of the grant. The closeout report summarizes the following:

- Grant application and approval award
- Procurement
- How environmental and historic review requirements were met, as applicable
- Use of administrative allowance
- For buyout projects, final list of properties acquired with copies of any deed restrictions
- For elevation projects, copy of deed restriction requiring flood insurance purchase
- Summary of costs incurred
- Verification of project monitoring and correspondence

- For buyout projects, demolition (open space)
- Certificate of Completion

Closeout reports are submitted 90 days after notification by quarterly report that a project has been completed, to include demolition and site remediation (if applicable).

Audit Requirements

44 CFR 14, Administration of Grants: Audits of State and Local Governments, requires all subgrantees receiving $500,000 or more in federal assistance to have an audit conducted in accordance with the Single Audit Act. Such reports by an independent certified public accountant are maintained by SEMA. All general audit requirements in 44 CFR 14 are adhered to by SEMA as well as by subgrantees receiving FEMA hazard mitigation grant awards.

2007 Plan Update

As part of the update to the Missouri State Hazard Mitigation Plan, the previously approved plan's monitoring system for implementation of mitigation measures and project closeout was evaluated. It was determined that the monitoring system described herein to track the initiation, status, and closeout of mitigation activities was effective. No changes to this process have been made. The SHMO continues to have primary responsibility for continued management and maintenance of the monitoring system. Future reviews will be conducted in accordance with the process and schedules established for the plan maintenance process. A description of mitigation actions implemented since the 2004 Missouri State Hazard Mitigation Plan development is in Section 4.4.4 Review and Progress of Mitigation Actions.

6.2.2 Progress Review for Mitigation Goals, Objectives, and Activities

A review and update of the state's system for conducting a progress review of mitigation goals, objectives, and actions is also conducted as part of the plan maintenance process. This section includes a description of the state's process for monitoring the progress of mitigation goals, objectives, and actions and any modifications to the system identified during the 2007 plan update.

Mitigation Progress Review System

In order for any program to remain effective, the goals and objectives of that program must be reviewed periodically. That review should answer, at a minimum, the following questions:

- Are the established goals and objectives realistic? (Take into consideration available funding, staffing, state/local capabilities, and the overall state mitigation strategy.)
- Has the state clearly explained the overall mitigation strategy to local governments?
- Are proposed mitigation projects evaluated based on how they help the state and/or local government meet their overall mitigation goals and objectives?

- How have approved mitigation projects complemented existing state and/or local government mitigation goals and objectives?
- Have completed mitigation projects generated the anticipated cost avoidance or other disaster reduction result?

A thorough and realistic evaluation of the benefits of a mitigation project may be delayed until the area of the project is impacted by another disaster. The lack of realized benefits from a completed mitigation project may result in the disapproval or modification of similar projects in the future. At the same time, mitigation projects that have proven their worth may be repeated in other areas of the state.

Based on the results of the review/evaluation of mitigation progress described above, the state may need to adjust its goals and objectives to meet the current and future mitigation needs of the state and local governments. A formal mitigation status report is prepared by SEMA's Logistics, Mitigation and Floodplain Management Branch on an annual basis. This report is provided to the SEMA director and deputy director for review and distribution, as needed.

2007 Plan Update

For this update to the Missouri State Hazard Mitigation Plan, the system for reviewing progress on achieving goals as well as progress of mitigation activities was evaluated. It was determined that the process stated herein to monitor progress was effective. A few additions and clarifications to this process have been made where warranted. The following paragraphs include additions and modifications to the process implemented during the 2007 plan update.

As part of the 2007 plan update process, the goals and objectives outlined in the 2004 plan were reviewed to determine if they still address current and anticipated future conditions. This was accomplished during a planning meeting and during focused meetings with SEMA mitigation staff. The HMPT evaluated the goals and objectives based on the process outlined above. In addition, the review was based on:

- The updated statewide risk assessment, including changes in development, recent disasters, and analysis of local risk assessments;
- Assessment of changes and challenges in state and local capabilities since the 2004 plan;
- Analysis of the similarities and differences of the state mitigation plan goals with local mitigation plan goals and objectives; and
- Identification of achieved mitigation objectives from the 2004 plan.

This review of the 2004 goals and objectives and modifications to the review process are described in more detail in Section 4.1.2 Process for Identifying, Reviewing, and Updating State Goals and Objectives. These additional review criteria have been added to the process for reviewing progress on achieving plan goals and objectives.

The status of mitigation actions were also evaluated to ensure that the state is making progress with its overall mitigation strategy. Conducting a comprehensive review of state goals and objectives in conjunction with identified mitigation actions helps ensure consistency with Missouri's overall mitigation goals.

Progress of identified mitigation actions is measured based on the following variables:

- The number of projects implemented over time
- The successful disbursement of mitigation grant funds over time
- The disaster losses avoided over time (given a postdisaster event)
- Plans, partnerships, and outreach developed over time

This evaluation process is described in more detail in Section 4.3 Local Capability Assessment and Section 4.4 Mitigation Actions. These review criteria have also been added to this process for evaluating the progress of mitigation actions.

6.2.3 State Agency Responsibilities

State agencies continue to work together on program/project management and plan monitoring, evaluating, and updating activities listed in previous sections. This section details the roles and responsibilities of state agencies and staff duties as they relate to the plan maintenance process and the overall state hazard mitigation program. The state agencies that play a role in mitigation, and also make up the Hazard Mitigation Planning Team (HMPT), include the following:

- Missouri State Emergency Management Agency
- Missouri Department of Agriculture
- Missouri Department of Conservation
- Missouri Department of Corrections
- Missouri Department of Economic Development
- Missouri Department of Elementary and Secondary Education
- Missouri Department of Higher Education
- Missouri Department of Heath and Senior Services
- Missouri Department of Insurance, Financial Institutions, and Professional Registration
- Missouri Department of Labor and Industrial Relations
- Missouri Department of Mental Health
- Missouri Department of Natural Resources
- Missouri Department of Natural Resources Division of Geology and Land Survey
- Missouri Department of Social Services
- Missouri Department of Transportation
- Missouri Office of Administration
- Missouri Public Service Commission
- Missouri State Highway Patrol

These agencies:

- Review proposed hazard mitigation projects to ensure they are in compliance with the state's mitigation priorities,
- Explore all potential sources of mitigation funding to ensure the state can maximize hazard mitigation implementation opportunities,
- Ensure proposed mitigation projects do not conflict with other state/local initiatives, and
- Participate in the development, review, and update of the Missouri State Hazard Mitigation Plan, as needed.

Some state agencies have additional mitigation responsibilities. These are described in more detail in the following pages.

State Emergency Management Agency

The State Emergency Management Agency (SEMA) hires temporary employees and uses contractor assistance as needed to support hazard mitigation initiatives but in general manages hazard mitigation programs through the work of the Logistics, Mitigation and Floodplain Management Branch.

The Mitigation Section:

- Administers and supervises the Missouri State Hazard Mitigation Program;
- Serves as lead agency on the Hazard Mitigation Planning Team;
- Serves as the lead agency for the coordination, development, review, and updates of the Missouri State Hazard Mitigation Plan;
- Publicizes hazard mitigation program availability;
- Educates potential applicants on the hazard mitigation program and potential hazard mitigation opportunities;
- Establishes priorities for use of available mitigation funds;
- Reviews hazard mitigation projects for compliance with established state mitigation goals and objectives; and
- Reviews hazard mitigation projects for cost-effectiveness.

The Floodplain Management Section:

- Provides technical assistance/personnel to resolve National Flood Insurance Program (NFIP) issues;
- Provides and/or interprets floodplain maps, as needed, to resolve issues concerning applicability of NFIP regulations;
- Determines community NFIP participation; and
- Promotes NFIP and CRS participation.

Missouri Department of Transportation

The Missouri Department of Transportation:

- Provides technical assistance as needed to resolve hazard mitigation related issues,
- Provides technical assistance concerning environmental studies and environmental impact statements relating to the National Environmental Policy Act,
- Reviews mitigation projects for potential conflict with current or future highway projects, and
- Identifies and implements transportation safety projects, such as bridge design or retrofitting to mitigate flood and earthquake damage.

Department of Natural Resources

The Department of Natural Resources (DNR):

- Provides technical assistance to state hazard mitigation personnel concerning DNR-related issues and
- Provides technical assistance to state hazard mitigation personnel concerning historic preservation related issues.

Office of Administration

The Office of Administration:

- Processes vouchers and issues checks for eligible hazard mitigation applicants/projects based on warrant requests provided by SEMA's fiscal branch (Division of Accounting);
- Maintains financial records (Division of Accounting); and
- Provides technical assistance to resolve hazard mitigation related issues, as needed and available (design and construction).

State Auditor

The state auditor:

- Performs audits as required by applicable laws and regulations and forwards copies of those audits to SEMA hazard mitigation staff and
- Provides documentation guidance to applicants, as needed.

Department of Insurance, Financial Institutions, and Professional Registration

The Department of Insurance, Financial Institutions, and Professional Registration:

- Provides technical assistance regarding problems encountered with insurance companies during disaster situations (specifically increased cost of compliance issues) and

- Provides advice regarding insurance rules and regulations.

Department of Conservation

The Department of Conservation:

- Provides technical assistance to state hazard mitigation personnel concerning conservation-related issues;
- Provides technical assistance to state hazard mitigation personnel concerning endangered species related issues; and
- Coordinates or assists, on a case-by-case basis, on hazard mitigation projects.

Department of Labor and Industrial Relations

The Department of Labor and Industrial Relations:

- Through the Division of Labor Standards, provides information on Missouri Labor Standards and
- Provides personnel, as needed, to assist and educate state and local hazard mitigation staff on Missouri Prevailing Wage and Child Labor Laws.

Department of Economic Development

The Department of Economic Development (DED):

- Provides technical assistance to state hazard mitigation personnel concerning DED-related issues,
- Coordinates potential availability of Community Development Block Grant funds to assist the state and local hazard mitigation staff with mitigation projects, and
- Provides information related to small and impoverished community status.

Department of Health and Senior Services

The Department of Health and Senior Services:

- Provides technical assistance regarding disease surveillance to local public health agencies;
- Provides laboratory services for biological agents of concern for terrorism use;
- Conducts laboratory testing for natural biological agents;
- Reviews local public health agency plans; and
- Provides public health technical assistance to hospitals, physicians, and other healthcare professionals.

6.2.4 Staffing

In addition to the duties of the HMPT, SEMA implements and updates the state plan and administers the mitigation programs using the following positions:

State Hazard Mitigation Officer

The governor's authorized representative (GAR) designates the state hazard mitigation officer (SHMO). Pursuant to 44 CFR 206.437(b)(2), the GAR identifies the SHMO. At SEMA, the SHMO has overall management responsibility for the mitigation program and is the state official who is ultimately responsible for ensuring that the state properly carries out its Section 404 responsibilities subsequent to a presidential disaster declaration. In this regard, the SHMO monitors and oversees the activities of the emergency management coordinator for hazard mitigation, the emergency management specialist for hazard mitigation, any mutual aid provided hazard mitigation specialists, any contracted support for hazard mitigation, other staff support for the program, and the State Hazard Mitigation Team (when employed). The SHMO coordinates with other SEMA staff and other state executive departments as necessary to ensure the program work required of the state is accomplished for delivering fairly and effectively to eligible subgrantees the Hazard Mitigation Grant Program, as well as the Flood Mitigation Assistance, Pre-Disaster Mitigation (PDM), Repetitive Flood Claims, and Severe Repetitive Loss grant programs.

Emergency Management Coordinator (Hazard Mitigation)

A senior emergency management coordinator for hazard mitigation serves as the primary assistant to the SHMO to help plan, organize, coordinate, implement, and administer hazard mitigation projects, including planning projects, and to promote, manage, and evaluate mitigation issues. The coordinator helps accomplish the necessary program work required of the state to deliver the Hazard Mitigation Grant Program as well as the Flood Mitigation Assistance, Pre-Disaster Mitigation, Repetitive Flood Claims, and Severe Repetitive Loss programs.

Emergency Management Specialist (Hazard Mitigation)

An emergency management specialist for hazard mitigation assists the SHMO in organizing, coordinating, implementing, and administering hazard mitigation projects, including planning projects, and the promotion, development and evaluation of mitigation issues. The specialist helps accomplish the necessary program work required of the state to deliver the Hazard Mitigation Grant Program as well as the Flood Mitigation Assistance, Pre-Disaster Mitigation, Repetitive Flood Claims, and Severe Repetitive Loss programs.

Responsibilities of the SHMO, hazard mitigation staff, and others include, but are not limited to:

- Ensuring the Missouri Hazard Mitigation Grant Program Administrative Plan is updated, outlining how the state will administer the Hazard Mitigation Grant Program and implementing it during a disaster;
- Ensuring that the Missouri State Hazard Mitigation Plan is active, identifying potential hazard mitigation projects, and establishing priorities among those projects;
- Coordinating with the federal hazard mitigation officer in determining the composition of the interagency hazard mitigation team or hazard mitigation survey team when one is established (and its schedule of activities), in estimating the amount of FEMA money available for the Section 404 program, and in administering the program, including submitting required reports to FEMA (all coordination will take into consideration the priorities and procedures as set by the Missouri State Hazard Mitigation Plan);
- Coordinating with state and federal officials to ensure that they understand the involvement of the hazard mitigation effort in the Public Assistance program;
- Ensuring that potential applicants are notified of the mitigation grant programs and receiving the assistance to which they are entitled;
- Developing and implementing a process for identifying potential hazard mitigation projects and for setting priorities among those projects;
- Ensuring that a proper initial application and benefit-cost analysis, and any necessary supplemental applications, including SF-424's, are prepared, coordinated, and submitted in a timely fashion to the FEMA regional director;
- Ensuring that technical assistance is provided to potential applicants and/or eligible subgrantees in developing and submitting applications and benefit-cost analyses and in managing and completing approved mitigation projects, to include site visits as necessary;
- Ensuring development of a system to monitor the status of approved projects, for processing extension requests and appeals, and for closing out completed projects;
- Ensuring that adequate procedures are developed for the distribution of financial assistance to eligible subgrantees;
- Ensuring that a system exists to monitor subgrantee accounting systems and compliance with 44 CFR parts 13 and 14;
- Ensuring a computer management system and/or files are maintained for hazard mitigation activities and products;
- Ensuring that appropriate state agencies and divisions are involved as necessary with the hazard mitigation process to include coordination with the SEMA Floodplain Management Section; and
- Ensuring the required performance reports, such as quarterly reports and closeout reports, are submitted to FEMA in a timely fashion.

Other SEMA Staff Involvement

The SEMA director (GAR) and deputy director provide overall guidance, direction, and support for the mitigation program.

The Logistics, Mitigation and Floodplain Management Branch chief provides direct supervision of, as well as general guidance, direction, and support for the SHMO who manages the mitigation program.

The Floodplain Management Section performs numerous mitigation related activities, training, and technical support functions that are associated with managing statewide local government participation in the National Flood Insurance Program (NFIP), serving as a state cooperating technical partner in developing and updating floodplain flood insurance rate maps and directly performing flood permitting for all state-owned construction projects. The personnel in the Floodplain Management Section include the floodplain engineer and two floodplain management officers.

The Logistics Section is responsible for developing, managing, and providing SEMA's logistics support and training efforts for local jurisdictions. Mitigation and Floodplain Management Section personnel directly support the Logistics Section during emergency response and then transition to their normal duties during the recovery. However, the performance of the initial disaster logistics needs assessments in the disaster areas enables the participating mitigation staff members to perform a quick assessment of potential mitigation success stories, projects, and the possible need for a dedicated hazard mitigation survey team as well as determine if structures might be substantially damaged. The Floodplain Management and Mitigation Section administrative assistants work under the supervision of the Logistics Section chief to provide direct daily administrative, clerical, marketing, and database management support for the mitigation program.

SEMA augments the staff in each of the three sections of the Logistics, Mitigation and Floodplain Management Branch as needed with contracted services from Missouri's 19 Regional Planning Commissions (especially planning, planning reviews, project management, and closeout reports), a local engineering firm (for training, surveying, and low cost—mostly floodplain management—minor engineering projects), and a larger engineering firm with a team of partners (mitigation training, benefit-cost analysis assistance, mitigation application development, map modernization program management, complex engineering projects, special projects, etc.). This enables SEMA to surge during times of disaster to more effectively manage larger numbers of mitigation projects and to keep up with the administrative requirements of managing a larger number of mitigation grants.

The mitigation program also is supported by the Fiscal Branch staff as related to the financial aspects of administering the awarded grants for projects and plans through interaction of the grantee (state) with FEMA.

In addition, the mitigation program staff also work in coordination with the Public Assistance staff to determine the feasibility of mitigation projects in support of Public Assistance following disasters.

7.0 Enhanced Plan

This plan in its entirety demonstrates the comprehensive nature of Missouri's state hazard mitigation program and provides the foundation for SEMA's Mitigation Section's mission statement, which is "To develop, manage, and administer mitigation programs designed to accomplish activities and projects, develop plans, conduct training and exercises, and provide public education in a manner that promotes public safety and mitigates economic losses, property damage, human injuries, and losses of life from disasters that threaten the State of Missouri." This enhanced section illustrates how the state has taken extra steps to commit to mitigation and the creation of safe communities throughout Missouri, a commitment that has evolved over multiple decades with the assistance of many groups and individuals, and a commitment that continues to evolve today.

Among these extra steps is Missouri's participation in the Emergency Management Accreditation Program (EMAP). EMAP is the voluntary assessment and peer-reviewed accreditation process for state and local government programs responsible for coordinating prevention, mitigation, preparedness, response, and recovery activities for natural and manmade disasters. Accreditation is based on compliance with collaboratively developed national standards, the EMAP Standard. The EMAP Standard is based on the 2004 NFPA (National Fire Protection Agency) 1600 Standard on Disaster/Emergency Management and Business Continuity Programs. By complying with the EMAP mitigation standards, Missouri has demonstrated the importance it places on emergency management, including mitigation, and is better prepared to protect its residents and property from hazards.

This chapter addresses six elements of mitigation planning, consideration of which are critical for a successful mitigation program:

- Integration with Other Planning Initiatives
- Project Implementation Capability
- Program Management Capability
- Assessment of Mitigation Actions
- Effective Use of Available Mitigation Funding
- Commitment to a Comprehensive Mitigation Program

Requirement §201.5(b):	Enhanced state mitigation plans must include all elements of the standard state mitigation plan identified in §201.4.

The Missouri State Hazard Mitigation Plan contains all the elements required of a standard state mitigation plan. FEMA Region VII concurred and approved the standard plan on July 26, 2007.

7.1 Integration with Other Planning Initiatives

Requirement §201.5(b)(1):	[An enhanced plan must demonstrate] that the plan is integrated to the extent practicable with other state and/or regional planning initiatives (comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans) and FEMA mitigation programs and initiatives that provide guidance to state and regional agencies.

The State of Missouri has established a comprehensive state hazard mitigation program that is multidirectional. State mitigation initiatives are integrated with Federal Emergency Management Agency (FEMA) programs and are designed to integrate both federal and state programs into local planning efforts. State mitigation planning is also integrated with other state emergency management efforts as well as other state and regional planning initiatives. This section of the plan demonstrates how Missouri's State Hazard Mitigation Plan is integrated with other state and regional planning initiatives and FEMA mitigation programs. It discusses new initiatives that have been implemented since the 2004 plan and integration challenges and successes.

7.1.1 Continued Integration of the Mitigation Plan

State Emergency Management Planning

The Missouri State Hazard Mitigation Plan is a standalone document, but it is closely linked to the Missouri State Emergency Operations Plan (SEOP). The SEOP is the emergency management umbrella document, which includes several annexes that focus on specific tasks related to emergency management, such as fire suppression, mass care, and radiological protection. SEMA and the state's Executive Department recently collaborated on the Catastrophic Event (Earthquake) Annex, which has been added to the SEOP. The SEOP and the Missouri State Hazard Mitigation Plan are both based on the same hazard analysis and developed in cooperation with the other state agencies. The Missouri Hazard Analysis is updated annually and is incorporated into this plan as Section 3.1 Identifying Hazards and Section 3.2 Profiling Hazards. The Missouri Hazard Analysis directly impacts the mitigation priorities that the state sets, which impacts the type of projects the state considers for funding if and when funding becomes available. Upon successful completion of a mitigation project, the impact of the

targeted hazard is evident by the reduction of loss of life and injuries, damage to infrastructure and other property, and the general removal of people from harm's way. Subsequently, this diminishes the emergency response required for a hazard-related event. The mitigation plan strategies are considered a natural outcome of emergency operations. The implementation of both plans is reviewed under single after action activities.

Other State Planning Initiatives

The integration of the mitigation plan with other state planning initiatives primarily occurs through the assessment of state capabilities in the mitigation planning process, through data-sharing between state plans, and through participation on planning committees and policy commissions.

During the 2007 plan update, the Hazard Mitigation Planning Team (HMPT) reviewed mitigation-related plans and programs of other state agencies. The purpose of this review was to identify relevant data and capabilities to incorporate into the mitigation plan and to better understand areas where mutual responsibilities and policies could be leveraged. Information on this assessment can be found in Section 4.2 State Capability Assessment.

The mitigation plan is also integrated with other state planning initiatives through data sharing. For instance, the mitigation plan was used by the Departments of Transportation; Insurance, Financial Institutions, and Professional Registration, Corrections; Natural Resources; and Education and the Office of Administration and the Public Service Commission to develop their earthquake plans. State agencies have also used information in the mitigation plan to develop and update their emergency operations plans. The Department of Transportation uses mitigation in its capital improvement planning and in environmental planning that involves locating facilities, retrofitting bridges, and assessing open space and floodplain issues. The state also considers mitigation in its capital improvements planning (e.g., in designing and siting new facilities).

The planning initiatives of different agencies are also integrated with the state hazard mitigation plan through participation in multiagency planning committees and policy commissions. Through the HMPT, SEMA planners are made aware of the data, programs, and priorities of other state agencies, and other agencies become more knowledgeable about mitigation policies and programs and how they can be integrated into their own plans. SEMA also participates on the Seismic Safety Commission and will provide information for the upcoming update of the state's Strategic Plan for Earthquake Safety.

A number of mitigation actions are spelled out in various state laws, interdepartmental agreements, regulations, plans, and program documents. The state agencies have institutionalized mitigation practices not only by policy actions described in the state hazard mitigation plan but also by following their daily operations statutory requirements. Statutory requirements regulate individual agency policies and operational and budgetary functions. State agencies participate in the development of coordinated mitigation policies, priorities, and

projects. This ensures their individual mitigation needs are known and met when possible. Other ways in which mitigation is integrated into state agencies include the following:

- All state departments, such as the Departments of Transportation, Conservation, Natural Resources, and Health and Senior Services and the Office of Administration get permits through SEMA for projects in the floodplain to mitigate flooding.
- The Department of Transportation's St. Louis Bridge Earthquake Retrofit Program focuses on building new bridges to withstand earthquakes.
- The Department of Health and Senior Services offers programs for mitigating health problems in Ready in 3 and exercises.
- The Missouri Department of Conservation and the Department of Natural Resources offer programs to mitigate environmental damages.
- SEMA Mitigation staff provide training to the Regional Planning Commissions (RPC) and local governments, including classes on mitigation planning, benefit-cost analysis, and grant applications. In turn, the RPCs help educate communities about the importance of mitigation in community economic development planning and area transportation plans.

For more information about the role of state agencies in mitigation, see Section 4.2 State Capability Assessment, Table 4.9 Analysis of Considerations Used Daily in Fulfilling the State Mitigation Strategy, and Table 4.3 Missouri State Policies Related to Hazard Mitigation.

FEMA Mitigation Programs

The mitigation plan is integrated with FEMA mitigation programs primarily through its mitigation strategy and the local mitigation planning program. This plan's mitigation actions, which are described in detail in Section 4.4 Mitigation Actions, are designed to reduce long-term risk in Missouri and improve the state's eligibility for and management of FEMA mitigation grant programs. For example, development of a GIS-based mitigation project database will allow the state to better track the effectiveness of FEMA-funded mitigation projects. The state also encourages local participation in the National Flood Insurance Program, the Community Rating System, and the flood buyout program. Other actions include helping local governments with their local hazard mitigation plans (new and updated), which are funded primarily through FEMA's Pre-Disaster Mitigation program and Hazard Mitigation Grant Program, and providing training and outreach to local governments about the benefits of FEMA mitigation programs and how they can get involved.

In updating the Missouri State Hazard Mitigation Plan, SEMA made extensive use of HAZUS-MH, FEMA's loss estimation modeling tool, and included the flood and earthquake results for every county in Missouri in the plan. To further integrate the state plan with local plans, SEMA will share these results with local governments for use in their mitigation planning purposes.

7.1.2 Planning Initiatives since the 2004 Plan

Since the approval of the 2004 Missouri State Hazard Mitigation Plan, additional planning initiatives and mitigation strategies have been established. The Catastrophic Event (Earthquake) Annex was recently completed to meet the federal government's mandate that all states develop a catastrophic response plan. Missouri's plan focuses on a large earthquake because it is thought to be the most potentially catastrophic natural event that could affect the state.

In 2006, FEMA began the implementation of a five-year catastrophic planning initiative to prepare the nation for the consequences of catastrophic disasters. The first scenario to be addressed is a catastrophic earthquake in the New Madrid Seismic Zone, involving multiple states in a response and recovery exercise.

During the 2007 plan update, SEMA modeled earthquake and flood hazards using FEMA's HAZUS-MH software. A review of the initial earthquake results indicated that, by default, HAZUS-MH was assigning a mix of low and moderate seismic design levels to the building stock in Missouri and that a low seismic design classification more accurately represents the current conditions in Missouri. This change to the seismic design levels increased the building losses modeled by HAZUS-MH and will be incorporated into the regional catastrophic planning HAZUS-MH scenarios being conducted by FEMA and the Central United States Earthquake Consortium (among others). Ultimately, this information and analysis may be integrated into the National Incident Management System and the National Response Plan.

The extensive HAZUS-MH flood and earthquake modeling done during the 2007 update is testimony to Missouri's commitment to better defining and understanding the risk to the state's citizens and infrastructure. Two independent reviews of the HAZUS-MH earthquake scenario results were performed as part of the update planning process. These reviews verified the ground motion inputs developed for an M7.7 scenario on the northwest New Madrid Seismic Zone by the USGS. The reviews verified the results of the HAZUS-MH scenario, but cautioned that damage and casualties in the St. Louis area may be underestimated. The reviews identified limitations in the HAZUS-MH model (see Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction) and suggested ways that may improve the results in future studies. Closer contour intervals for ground shaking inputs in the St. Louis area for potential ground acceleration, spectral acceleration, and potential ground velocity may provide more accurate results. Another recommendation was to run the 2,500 year HAZUS-MH earthquake scenario to assess the worst-case impacts to Missouri. The results of this analysis are summarized in Section 3.3 and details are provided in Appendix F HAZUS-MH Earthquake Results: 2,500 Year Scenario Global Summary Report.

The best example of the integration of state mitigation planning into regional and local planning initiatives from the last three years is evidenced by SEMA's relationship with Missouri's Regional Planning Commissions (RPCs). Because of their involvement in the development of local mitigation plans, the RPCs are more cognizant of mitigation and can consider the basic

principles of mitigation in the other planning efforts they coordinate, including highway planning, comprehensive planning, and capital improvement planning. For example, they can promote regional water interconnects between cities to create supply alternatives should a hazard event disrupt this critical utility. This would also serve and support homeland security considerations and requirements.

7.1.3 Challenges in Planning Integration

This 2007 update reflects the successful integration of 82 percent of the county-level plans, which equates to coverage for 94 percent of Missouri's population. Since Missouri has 115 counties (including St. Louis City) and 948 incorporated cities, towns, and villages, SEMA was challenged with how to effectively and efficiently develop plans for each of the jurisdictions. SEMA streamlined the process by encouraging local governments to participate in multijurisdictional county-level plans, which cut down on the number of plans that needed to be reviewed and integrated and brings communities together to focus on mitigation. SEMA is trying to obtain budget to hire a new mitigation planner in mid-2007 to work with local plans on a regular basis.

By providing local mitigation planning guidance detailing form and content requirements, SEMA had hoped to further streamline the integration of local plan data into the state plan. While it did prove to be a successful tool (as evidenced by the high number of plans approved), local risk assessments used different methods and interpretations to determine vulnerability and different measures to assess risk. Therefore, it was challenging to compare the counties to see where one might be more vulnerable to a particular hazard than another. (More information about the challenges of the local risk assessment integration can be found in Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction, Section 4.1 Hazard Mitigation Goals and Objectives, Section 4.3 Local Capability Assessment, and Section 4.4 Mitigation Actions.)

Another challenge or obstacle to integrating this plan with other planning initiatives and efforts identified during the 2007 update process was the timing of disasters during the planning process. Missouri experienced a major ice storm and flood while this plan was in the process of being updated, and both resulted in presidential disaster declarations. This impacted the availability of state agency staff to participate and contribute in HMPT meetings, as they were busy with the disaster recovery efforts. Those agencies that could not be represented at meetings were followed up with by the SEMA on-site planner to obtain necessary information and receive comments on the draft plan, but the downside of this was less face to face HMPT interaction. In future updates, it is recommended that the update process begin nine months or more before the update is due to ensure enough time for participation.

A final challenge to integration is that Missouri, like many other states, is a home-rule state. There are no local building codes or regulations enacted under state authority. Land development and use regulations are enacted by local governments. The most common regulation

implemented at the local level is floodplain management. A number of counties also regulate the earthquake hazard. Specifically, 47 counties (out of 114 counties) plus the City of St. Louis require earthquake building codes for public buildings in excess of 10,000 square feet. These are the counties most vulnerable to earthquake damage. Those counties that have adopted local building codes or land use regulations make reference to such programs in their local hazard mitigation plans.

SEMA is making a concerted effort to help local governments with hazard-related regulations. For example, SEMA has designed a website capability that allows communities to apply for the Community Rating System (CRS) online. This includes assistance with ordinance development and a floodplain regulations bulletin board. The state cannot make local governments implement CRS programs, but through SEMA, they regularly provide CRS awareness and education via SEMA's website; SEMA's Map Modernization website; SEMA's mitigation website; the SEMA, Emergency Management Directors, Mitigation, and Missouri Floodplain and Stormwater Management Association (MFSMA) newsletters; the MFSMA, SEMA, and Association of State Floodplain Manager's Annual Conferences; and the Missouri Department of Insurance, Financial Institutions, and Professional Registration and other professional associations that include agents, lenders, realtors, and appraisers.

More information on integration with other planning efforts can be found in Section 4.3 State Capability Assessment; Section 4.4 Mitigation Actions, Table 4.9. Analysis of Considerations Used Daily in Fulfilling the State Mitigation Strategy; and Section 5.2 Local Plan Integration.

7.2 Project Implementation Capability

Requirement §201.5(b)(2)(i) and (ii):	[The enhanced plan must document] the state's project implementation capability, identifying and demonstrating the ability to implement the plan, including: • Established eligibility criteria for multihazard mitigation measures. • A system to determine the cost-effectiveness of mitigation measures, consistent with OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, and to rank the measures according to the state's eligibility criteria.

Over the years, the state has developed and demonstrated mechanisms to implement mitigation plans and projects, including this Missouri State Hazard Mitigation Plan and the processes explained herein. SEMA has established criteria for projects, including multihazard considerations, and uses FEMA's recommended benefit-cost analysis system to determine cost-effectiveness of and assign priority to potential mitigation activities.

This section describes the Missouri State Hazard Mitigation Plan's eligibility criteria and cost-effectiveness determination procedures. It also demonstrates how Missouri addresses the

effectiveness and adequacy of the state's established eligibility criteria for multihazard mitigation actions; the effectiveness of its system for determining cost-effectiveness of those actions consistent with OMB Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*; and the effectiveness of its approach to using cost-effectiveness as part of its eligibility criteria.

In addition, this section also describes how the state evaluates cost-effectiveness, the procedures for which are consistent with Missouri's Hazard Mitigation Grant Program Administrative Plan for managing the various hazard mitigation grant programs. It is now the responsibility of the local government submitting a grant application to perform a benefit-cost analysis (BCA) for each project. SEMA trains applicants on how to perform BCAs using FEMA software and then reviews the application submittals for accuracy and cost-effectiveness. SEMA also recruits the assistance of RPCs in providing BCA assistance to local jurisdictions.

Effectiveness is evidenced by the fact that 90+ percent of projects submitted have been funded, and future losses were avoided in cases where a hazard affected a project site after its completion, e.g., significant savings were realized following the 1995 floods that succeeded the 1993 postflood buyouts. Additionally, the national Multihazard Mitigation Council report, *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities* (2006), determined that mitigation projects, nationwide, are providing a return on investment of 4-to-1. For more information about cost avoidance in Missouri, see Section 7.4.2 Postdisaster Progress Assessment/Review of Mitigation Goals, Objectives, and Measures and Appendix D Past Mitigation Projects.

7.2.1 Process Used to Evaluate and Prioritize Mitigation Actions

This section explains the process used to evaluate and prioritize mitigation actions. Local jurisdictions are strongly encouraged to incorporate mitigation actions, based on established natural hazard risk assessments, into all proposed development projects and as improvements to existing projects.

Funding will always be an important issue when considering mitigation actions. For the most part, state and federal mitigation funds are limited to nationally competitive Pre-Disaster Mitigation funds, annual allocations for flood loss prevention programs (Flood Mitigation Assistance, Repetitive Flood Claims, and Severe Repetitive Loss), and postdisaster Hazard Mitigation Grant Program funds. As such, a process has been developed to evaluate and prioritize proposed mitigation actions so that these limited funds are used most effectively among Missouri governments and residents.

SEMA has the primary responsibility for reviewing and evaluating mitigation projects submitted by local jurisdictions. The Hazard Mitigation Planning Team may be involved in the event of a large disaster. Broadly, SEMA uses STAPLEE (social, technical, administrative, political, legal, economic, and environmental) and the following criteria to rank mitigation actions:

1) Flood mitigation projects (repetitive loss properties high priority)
2) Tornadoes and high wind mitigation projects
3) Earthquake mitigation projects
4) Other, not direct life safety

STAPLEE is used as a screening tool to determine if the project makes sense and is worthy of consideration and implementation. During the 2007 update, HMPT members used STAPLEE at meeting #3 where the purpose was to update the state's mitigation goals and measures. New proposed mitigation actions developed during the planning process were presented and the HMPT was given the opportunity to review each action with the STAPLEE criteria in mind. The ideas that are presented as new actions in this plan underwent this screening as acceptable under STAPLEE. The new actions are automatically ranked using the above criteria and the mitigation action M category under which the project falls.

Specifically, SEMA uses the following list of questions to help guide the distribution of mitigation project funds:

- What is the hazard to be mitigated?
- Does the applicant have a FEMA-approved mitigation plan?[1]
- Does the project complement state and local mitigation goals and objectives identified in the mitigation plans?[2]
- Is the hazard being mitigated a priority hazard in the applicant's mitigation plan?
- Is the project cost-effective based on FEMA's benefit-cost analysis module?
- Does the project have the potential to substantially reduce the risk of future damage, hardship, loss, or suffering that may result from a major disaster?
- In the past, what mitigation efforts were undertaken by the applicant using local funds and initiatives and what were the outcomes?
- What is the applicant's disaster history?
- Are sufficient mitigation funds available to complete the project?
- Does the applicant have sufficient funds (if other funds are not available) to meet the local share of the project?
- Does the applicant have the capabilities to complete the project as submitted?
- Does the project independently solve a problem?
- Does the project have the potential to have a larger impact on the local and state mitigation program than other submitted projects?

[1] Small impoverished communities may be considered for a project grant if they do not have a plan as long as they complete a plan within 12 months of the project grant award (of the FEMA grants, this only applies to the Hazard Mitigation Grant Program).

[2] Since situations and priorities change over time, projects that are not in an applicant's mitigation plan may still be approved as long as they meet all other eligibility requirements.

- Does the project reduce impacts in an area experiencing growth and development pressures?
- Does the project have any negative impacts on neighboring communities?

When the funding comes from the Hazard Mitigation Grant Program (postdisaster funding), priority is given to mitigation projects related to the hazard that necessitated the disaster declaration and those jurisdictions included in the disaster declaration.

This plan does not differentiate or classify mitigation initiatives as primary or alternates. Mitigation initiatives will be evaluated and prioritized based on the criteria described above. Any mitigation project that is approved for funding is done so on the basis that it will benefit the community at large and therefore the state.

Information on this process is also included in Section 4.4.2 Process for Identifying, Evaluating, Prioritizing, and Updating Mitigation Actions and Section 5.3.2 Project Grants.

7.2.2 Eligibility Criteria for Multihazard Mitigation Projects

This section of the plan addresses the eligibility criteria for multihazard mitigation projects. The criteria listed in this section of the plan are the basic criteria for each type of project. These criteria may be modified based on any of the following issues:

- The specific disaster situation
- Location of affected areas
- Availability of funds
- Unique program requirements of the fund source
- Current state and/or local hazard mitigation priorities
- Number/type of mitigation projects submitted by local governments

All hazard mitigation projects submitted for consideration must meet the criteria outlined in 44 CFR 206.434. To meet FEMA's minimum hazard mitigation project criteria, the project must:

- Be in conformance with the hazard mitigation plan developed as a requirement of Section 322;
- Have a beneficial impact upon the designated disaster area, whether or not located in the designated area;
- Be in conformance with 44 CFR 9, Floodplain Management and Protection of Wetlands, and 44 CFR 10, Environmental Considerations;
- Solve a problem independently or constitute a functional portion of a solution where there is assurance that the project as a whole will be completed (projects that merely identify or analyze hazards or problems are not eligible); and
- Be cost-effective and substantially reduce the risk of future damage, hardship, loss, or suffering resulting from a major disaster.

The project must also meet the following state criteria:

- The project must complement existing or proposed state mitigation goals and objectives;
- The project must complement existing or proposed mitigation goals and objects for the jurisdiction submitting the project;
- The jurisdiction requesting the project must be able to complete the project as submitted;
- The jurisdiction submitting the project must be able to meet any matching funds requirements (if required).
- The project must be able to make a bigger impact on the local and state mitigation program than other nonselected projects.

The systems in place continue to work well; therefore, the 2007 update did not add or eliminate any of the eligibility criteria or alter the system for determining the cost-effectiveness of mitigation actions.

7.2.3 Eligibility Criteria by Mitigation Project Type

SEMA considers a number of types of projects to be eligible for mitigation, in particular the 11 “M” action categories identified in Section 4.4 Mitigation Actions. All projects must be in conformance with at least one of these mitigation action categories. Flood mitigation projects continue to be the state’s highest priority, followed by tornado projects and then earthquake projects. Among the actions that mitigate these hazards, those that provide or protect life safety are the highest priority.

Flood Mitigation Projects

In each type of flood mitigation project discussed below, the sellers’ participation must be voluntary and the sellers must be able to prove ownership of the property involved in the project.

Property Acquisition

While buyouts are not the only mitigation projects considered and undertaken by the state and local governments, they have been the type of project most frequently submitted and approved. Property acquisition is SEMA’s most favored, and usually most cost-effective, voluntary option, because the people and property are totally and permanently removed from the path of flooding and danger.

In general, SEMA works with local governmental entities to acquire and remove, elevate, relocate, or perform minor structural projects on privately owned residential structures and/or privately owned lots that are located in the floodplain and/or floodway. In addition to the requirements listed in the previous section, these projects must also meet the following criteria:

- The project chosen must independently solve or be a functional part of a solution to a problem that is repetitive or poses a significant risk to health and safety. The proposed solution must be the most practical, effective, cost-effective, and environmentally sound

alternative among a range of alternatives that contribute to a long-term solution of the problem.

- Local governmental entities (and certain private nonprofit entities) must apply through the state, specifically SEMA, to FEMA for funding to perform a project or projects. The applications must specifically identify the properties to be included in the project or projects. All projects must be proven cost-beneficial in accordance with a determination method that is acceptable to SEMA and FEMA (e.g., FEMA's benefit-cost analysis software).
- Local governmental/nonprofit entities must be in good standing in the National Flood Insurance Program (or have not yet been mapped) and otherwise eligible to receive federal funding. Nonfederal matches and all other federal grant requirements must be satisfied by the local entity, sometimes with monetary assistance from local property owners or possibly SEMA or the Missouri Department of Economic Development.
- Hazard Mitigation Grant Program, Pre-Disaster Mitigation, Flood Mitigation Assistance, Repetitive Flood Claims, and Severe Repetitive Loss projects must be consistent with the Missouri State Hazard Mitigation Plan. Projects must also conform to 44 CFR 9, Floodplain Management and Protection of Wetlands, and 44 CFR 10, Environmental Considerations.
- Only local governmental/certain nonprofit entities, eligible special districts, or contractors representing these applicants may manage the project or projects. All projects must be managed in accordance with local, state, and federal ordinances, laws, and regulations. Individual property owners are not eligible to receive federal funds directly as a grantee or subgrantee and are not authorized to manage grant projects.

To be eligible to participate, the local governmental/nonprofit entity must agree to the following:

- The offer is based on preflood fair market value determined by a state board-certified appraiser or a postflood sales contract value.
- Duplication of Benefits, Small Business Administration loans, and private mortgages must be satisfied from proceeds first.
- The buyout property must be demolished within 90 days of the closing.
- Local governmental entities, and certain nonprofit entities, must accept all buyout property titles, which are officially annotated to comply (in perpetuity) with federal open space deed restrictions. SEMA verifies that the appropriate restrictions have been put in place as part of the project closeout process.
- The buyout property becomes ineligible for any future federal disaster assistance, except possibly Federal Crop Insurance.

Currently, it is SEMA policy that there will be no acquisition of commercial properties due to the expense.

Elevation

Elevation is a voluntary option that may be used if it is the more cost-effective and desirable option in the long run (e.g., when the cost of the land is so high that a buyout is impractical). To be eligible to participate, the local governmental/nonprofit entity must agree to the following:

- The elevation project must be a practical, cost-effective, and structurally sound alternative (in compliance with local building code and zoning rules) that elevates the lowest floor to an elevation at or above the base-flood elevation (BFE, also equivalent to water surface elevation of the 1 percent or 100-year flood) or to an elevation that complies with local floodplain management regulations, if more stringent, by:
  - Extending the walls of the house upward and raising the lowest floor (where appropriate, such as within an area with a moderate or greater earthquake risk, SEMA adds multihazard stipulations, e.g., requiring shear walls as part of an elevation project);
  - Converting the existing lower area of the house to nonhabitable space and building a new second story for living space; or
  - Lifting the entire house, with the floor slab attached, and building a new foundation to elevate the house.
- In A zones, property owners may elect to elevate buildings either on fill, an open foundation, or on continuous foundation walls that extend below the base-flood elevation. If continuous walls are used below the BFE, they must be equipped with openings that allow floodwaters to flow into and out of the area enclosed by the walls.
- Owners of substantially damaged houses in special flood hazard areas (SFHA) must be willing to relocate outside the SFHA, or voluntarily demolish the remnants of the house and build a new house on the same site with an elevated lowest floor at or above the BFE or at an elevation that complies with local floodplain management regulations, if more stringent.
- Alternatively, owners of substantially damaged houses in special flood hazard areas may elect to repair the house and elevate the lowest floor at or above the BFE or an elevation that complies with local floodplain management regulations, if more stringent, as part of the repair process.

Relocation

Relocation is a voluntary option that may be used if it is more practical/cost-effective or when the threat is so repetitive and/or severe that it is more advantageous to relocate a structure or structures, up to and including entire communities, entirely out of harms way. Relocation is also an alternative to rebuilding following a declaration of substantial damage. To be eligible to participate, the local governmental/nonprofit entity must agree to the following:

- Structures relocated from acquired property must be placed entirely outside the 100-year floodplain.
- Generally, structures must be relocated from acquired property within 90 days of closing.

- Ownership of acquired property may not be conveyed to private citizens or entities; ownership may be conveyed to other public entities or nonprofit organizations with the approval of the state and FEMA.
- Local governmental entities, and certain nonprofit entities, must accept all buyout property titles, which are officially annotated to comply (in perpetuity) with federal open space deed restrictions.
- Any buyout property (i.e., any vacated lots acquired through the project) becomes ineligible for any future federal disaster assistance, except possibly Federal Crop Insurance.

Floodproofing

Floodproofing is a voluntary option that may be most practical in limited danger areas. To be eligible to participate, the local governmental/nonprofit entity must agree that this measure will best resolve the danger to the property. To be eligible, the following must apply:

- The property is in an area that is not subject to flash flooding.
- Extensive cleanup normally is not required after a flood event.
- One of the two floodproofing processes described below is the most advantageous measure to employ in the long run.
  - ***Wet floodproofing*** allows water to enter the structure, thereby equalizing pressure on walls and floors. Building contents such as furnaces and appliances are relocated out of reach of the floodwater.
  - ***Dry floodproofing*** is a process that uses waterproofing compounds, sheeting, or other impermeable materials to prevent floodwaters from entering the structure. To maintain consistency with National Flood Insurance Program regulations, FEMA will not fund dry floodproofing of residential structures. FEMA may fund dry floodproofing of commercial structures, but protection must be up to at least one foot above the BFE or an elevation that complies with local floodplain management regulations, if more stringent.

Structural Mitigation Projects

Structural mitigation projects are infrastructure type mitigation projects sometimes associated with FEMA's postdisaster Public Assistance (PA) program. To be eligible for funding for structural mitigation projects, a jurisdiction and the project must meet all of the criteria of the federal/state public assistance program. Those criteria include, but are not limited to, the following:

- The project is required as a result of the declared event.
- The project is within the designated disaster area.
- The project is the legal responsibility of an eligible applicant.

With the above stipulations met, a community can incorporate improvements into the repair or replacement of an eligible damaged facility (e.g., replace a damaged culvert with a larger one, as long as it can be demonstrated to be technically feasible, cost-effective, and environmentally

sound). There are other types of structural flood mitigation projects that can be promoted and encouraged in addition to those that can be achieved through the PA program. For example, drainage projects or low-water bridge crossings are structural flood mitigation projects that do not require a disaster declaration or damage to a specific facility. These projects can be implemented with Pre-Disaster Mitigation or Hazard Mitigation Grant Program funds from FEMA.

Tornado Mitigation Projects

In addition to the relevant requirements for flood mitigation projects, projects to protect people from tornadoes and high winds, such as tornado safe rooms, must also comply with FEMA publications *Taking Shelter from the Storm: Building a Safe Room Inside Your House* (320) and *Design and Construction Guidance for Community Shelters* (361). Only eligible construction-related costs will be reimbursed by FEMA.

Earthquake and Other Mitigation Projects

The majority of Missouri's approved mitigation projects have resulted from flood-related disasters. The recent frequency of tornadoes has made tornado safe room projects the next most frequent type of mitigation project sought. Other projects, such as the following, may also be approved depending on the availability of funds, state and local priorities, and proof of benefit-cost and project submissions:

- Burial of power lines underground
- Structural seismic retrofit of undamaged critical facilities
- Nonstructural seismic retrofit of undamaged critical facilities (such as filming windows, strapping and bracing equipment, etc.)
- Development of educational programs and materials
- 5% State Initiative Projects

SEMA promotes a project identification framework from the National Flood Insurance Program's Community Rating System. The following six types of mitigation activities emphasize flood solutions; however, they can also be applied to other natural hazards:

- Preventative measures
- Structural projects
- Property protection measures
- Emergency services
- Natural resource protection
- Public information/education projects

7.2.4 Cost-Effectiveness of Mitigation Measures

A key criterion for mitigation projects to be eligible for funding is that they must be cost-effective. If the project benefits are higher than the project costs, then the project is cost-effective. The purpose of this section is to address the process used by the state to determine the cost-effectiveness of mitigation actions.

In order to ensure a consistent approach in determining the cost-effectiveness of all mitigation projects, the state uses FEMA's benefit-cost analysis (BCA) module and process, which is consistent with OMB Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. Since this is the method developed and used by FEMA to determine the cost-effectiveness of a project, it is reasonable for the state to use the same method. A BCA assesses a mitigation project based on the project, hazard, and benefit data provided in its grant application. SEMA encourages applicants to prescreen their proposed mitigation projects by using an upper-bound analysis, so that an early determination of cost-effectiveness can be made. Upper-bound analyses are used to identify projects that are not cost-effective.

It is understood that a positive benefit-cost ratio (greater than one) does not necessarily guarantee that a hazard mitigation project will be approved. However, by applying project specific information to the benefit-cost analysis module it is possible to get a good look at the mitigation potential associated with a project. The results of this analysis can also help communities evaluate current and future mitigation projects and adjust their overall mitigation strategy accordingly.

The following information serves to summarize the three-step process for determining a mitigation project's cost-effectiveness. This process is used for determining the cost-effectiveness of all mitigation project applications regardless of the type of mitigation measure.

1) Screen Project Application Data

The first part of the process is screening the project application to gather data related to cost-effectiveness. This includes economic, environmental, and engineering data. This data is often missing or limited. The amount of data available will determine the type of benefit-cost analysis used. The screening process involves three separate but related tasks. Each task is conducted simultaneously and is essential to developing an overall profile of the project before conducting the benefit-cost analysis.

- **Engineering Review—**This review establishes whether the project is feasible from an engineering standpoint and whether it will reduce damage as claimed. The reviewer may suggest changes to make the project more efficient in reducing damage and loss.
- **Environmental Assessment—**This part of the screening process alerts reviewers to any potential environmental concerns raised by the project.

- **Project Application Data Review**—This part of the screening process determines whether the application contains sufficient information and data for input into the benefit-cost model (see Table 7.1).

Table 7.1 shows the basic data that must be obtained from hazard mitigation applications before a benefit-cost analysis can be performed. This data is plugged-in to the benefit-cost module to assess whether the project is cost-effective or not. The examples are of key data typically used for analyzing flood and earthquake hazard mitigation projects. Nevertheless, the same basic information and analysis is needed for mitigation projects related to any type of hazard.

Table 7.1. Key Data Needed for Analyzing Project Applications

Subject	Flood Project Data	Earthquake Project Data
Hazard Data (often not included in application)	Flood insurance study data or historical flood data from application	Seismic hazard data from a credible source
First Floor Elevation	Is this available from engineering surveys or can it be estimated from observed flood depths?	Not applicable
Scope	What problem does the project address? How vulnerable is the building, item, or area?	Same as flood
Cost	Is there a well-documented cost-estimate or only a rough estimate?	Same as flood
Useful Lifetime	How long will the project provide protection (mitigation) against damage and losses?	Same as flood
Economic Considerations	What is the square footage of the building? What are the replacement values of the building (or other facility) and contents?	Same as flood
Occupancy	Not usually applicable	What are the levels of occupancy and visitors during various times throughout the day?
Function	What is the function of the facility and is it entirely or partially related to emergency response and recovery?	Same as flood
Damage Estimates—Before Mitigation	• What type of building is it? • Why does damage occur? • What is the historically-observed damage?	• Same as flood • Are engineering reports available that describe building/ facility seismic vulnerabilities?
Damage Estimates—After Mitigation	How effective will the mitigation project be in reducing future damage? (Reduced damage can be percent or dollar values)	Same as flood

2) Conduct a Benefit-Cost Analysis

The second part of the process is determining which benefit-cost analysis tool to use. Ideally, the project application contains all the data needed. However, project applications often have incomplete or limited data. This is one of the main reasons that a streamlined process was developed to determine project cost-effectiveness without all the data. It is also the reason that federal, state, and local mitigation specialists must work closely together to ensure that all proposed mitigation projects are thoroughly reviewed and comply with the mitigation goals and objectives. Rather than require additional information, which may or may not be available and which can cost valuable time and money, FEMA devised shortcuts. With these shortcuts, additional data does not necessarily need to be collected to do a benefit-cost analysis.

Screening the project data (step 1) helps determine which type of analysis to perform. If the project application data are limited or incomplete, then a benefit-cost analysis that uses limited data should be employed. If, however, the data in the project application are more or less complete, then a more robust method of analysis can be used.

Benefit-cost analysis is used for all cost-effectiveness determinations. At its most basic level, benefit-cost analysis determines whether the cost of investing in a mitigation project today (the "cost") will result in sufficiently reduced damage in the future (the "benefits") to justify spending money on the project. If the benefit is greater than the cost, then the project is cost-effective; if the benefit is less than the cost, then the project is not cost-effective. The benefit-cost ratio (BCR) is a way of stating whether benefits exceed projects costs, and by how much. It is figured by dividing the benefits by the costs. If the result is 1.0 or greater, then the project is cost-effective.

Example 1: The project cost is $1,000, and the value of damage prevented after the mitigation measure is $2,000. The BCR ($2,000/$1,000) is 2.0. Because the dollar value of benefits exceeds the cost of funding the project, and the BCR is greater than 1.0, the project is cost-effective.

Example 2: The project cost is $2,000, and the value of damage prevented after the mitigation measure is $1,000. The BCR ($1,000/ $2,000) is of 0.50. Because the cost of funding the project exceeds the dollar value of the benefits, and the BCR does not meet the 1.0 required for cost-effectiveness, the project is not cost-effective.

While these examples are oversimplifications, the process and the associated benefit-cost analysis calculations are basically the same for all mitigation projects. It is important to understand that benefit-cost analysis is basically the same for each type of hazard mitigation project. The only differences are the types of data that are used in the calculations, which depend on whether the project is for floods or earthquakes.

Three approaches are used to determine a project's benefit-cost ratio: lower-bound analysis, upper-bound analysis, and best estimate. The lower-bound and upper-bound methods are used in many cases to make final determinations of cost-effectiveness when there is limited data. In

other cases, quick screening analysis with these approaches yields inconclusive results and additional data and screening may be required. Best estimate analyses produce the most accurate results.

Lower-Bound Analysis

Lower-bound analysis is a powerful tool that can often demonstrate that projects are cost-effective even if the available data is not complete. A project's cost-effectiveness can sometimes be determined by using only one or two key pieces of data. The lower-bound analysis was developed with this in mind.

The lower-bound analysis considers only some of a project's benefits (those that are the most important or those for which data exist) and ignores other benefits that may be difficult to estimate or for which data may not be available. In other words, this analysis purposely uses only a few pieces of information and undercounts, or ignores, other benefits that may be gained by implementing the project. If results indicate that a project is cost-effective, then no further analysis is needed and no additional data has to be collected.

Lower-bound analysis at a glance:

- It should be used when data is incomplete.
- It can determine that a project is cost-effective.
- It cannot determine that a project is not cost-effective.
- It uses data for one or two significant benefits.

Upper-Bound Analysis

If a lower-bound analysis shows that a project is not cost-effective, then the next step is an upper-bound analysis. Sometimes an upper-bound analysis is used if, at first glance, the project appears not to be cost-effective. Like lower-bound analysis, upper-bound analysis relies on limited project data. Upper-bound analysis, however, also uses professional judgment to estimate which input data produce the highest reasonable benefits.

It is extremely important to note that upper-bound analysis cannot determine that a project is cost-effective. Because it relies on the highest reasonable estimate of benefits, an upper-bound analysis can only determine whether the project BCR is less than 1.0 and thus not cost-effective.

Upper-bound analysis at a glance:

- It can only determine that a project is not cost-effective.
- It is used as the next step if the lower-bound analysis is negative (not cost-effective).
- It is used if a project appears, at first glance, unlikely to be cost-effective.
- It uses the highest reasonable estimate of benefits for a project.
- It analyzes as many inputs as possible, assigning the highest reasonable value to each.

Best Estimate Analysis

A best estimate analysis is used when the project application data is complete, or almost complete. This analysis provides a more accurate BCR than either lower- or upper-bound analysis, because it considers more data in the analysis. As discussed earlier, however, in many cases lower-bound or upper-bound analysis can provide firm decisions about cost-effectiveness without requiring as much data as a best estimate analysis.

A best estimate analysis can determine if a project is either cost-effective or not cost-effective, because all significant data are considered. Because this method of benefit-cost analysis provides the best estimate of cost-effectiveness, it can be used to rank or set priorities among competing projects. Neither lower-bound nor upper-bound analysis are used to rank or set priorities among projects. They do not consider enough data to determine accurate BCRs; they only produce "bounds" on BCRs (i.e., BCR > 1.0 or BCR < 1.0).

Best estimate analysis at a glance:

- It should be used when the project application data is complete, or almost complete.
- It produces a more accurate analysis than lower-bound and upper-bound analyses.
- It determines whether a project is cost-effective or not cost-effective.
- BCR can be used for ranking or setting priorities among projects.

3) Review the Results of Benefit-Cost Analysis

The final step of the review process is to determine whether a project is cost-effective or whether further analysis is required. There are three possible outcomes to a benefit-cost analysis: the project is deemed cost-effective (BCA > 1.0), the project is deemed not cost-effective (BCA < 1.0), or additional data may be required.

Typically, if the project is cost-effective as determined by a lower-bound or best estimate analysis, then no further analysis or additional data collection is required and the application moves to the next level in the funding process. If the project is not cost-effective as determined by an upper-bound or best estimate analysis, then no further analysis or additional data collection is required and the project is rejected. In some cases, additional information may be requested, or the applicant may be shown how the mitigation effort can be redirected. In general, for the Pre-Disaster Mitigation grant program, it is an advantage to maximize benefits (e.g., BCA > 1.0) to make the application more competitive.

If the cost-effectiveness of a project cannot be determined, then additional data must be collected. It is important to recognize that only the minimum data necessary to reach a decision on project cost-effectiveness must be collected. In many cases, the collection of one or two pieces of information is sufficient to reach a decision. A complete analysis is conducted for those relatively few cases where the BCA is close to 1.0.

7.3 Program Management Capability

Requirement §201.5(b)(2) (iii A-D):	[The enhanced plan must demonstrate] that the state has the capability to effectively manage the HMGP as well as other mitigation grant programs, [and provide] a record of the following: • Meeting HMGP and other mitigation grant application timeframes and submitting complete, technically feasible, and eligible project applications with appropriate supporting documentation; • Preparing and submitting accurate environmental reviews and benefit-cost analyses; • Submitting complete and accurate quarterly progress and financial reports on time; and • Completing HMGP and other mitigation grant projects within established performance periods, including financial reconciliation.

According to FEMA's *Multi-Hazard Mitigation Planning Guidance under DMA 2000*, "FEMA regional offices will certify that the state has the capacity to effectively manage the HMGP, FMA, and PDM programs. The state is not required to document this in their plan."

7.3.1 Managing State Capability for Hazard Mitigation

Since Section 322 of the Disaster Mitigation Act of 2000 provides for a significant increase in Hazard Mitigation Grant Program (HMGP) funding available to the state, it is critical that the state demonstrate its ability to manage the HMGP and other mitigation grant programs and its commitment to mitigation.

The following factors were developed by FEMA for considering a state for managing state status. Missouri meets all of these requirements and has been designated as a managing state for hazard mitigation since February 2001.

The State's Hazard Mitigation Planning Capabilities

SEMA's Mitigation Section has one individual solely devoted to hazard mitigation planning. In addition, the state uses an area coordinator system for emergency planning. These nine area coordinators have been instrumental in dealing with communities on a one-on-one basis.

Missouri has developed an All-Hazard Mitigation Planning Guidebook for Communities (describes the planning process) and a Regional Planning Commission Hazard Mitigation Planning Guide (details how to prepare plans and what the plans must contain) and continually offers assistance to communities that want to develop a mitigation plan. Hazard mitigation planning was a component of the state's disaster resistant community effort (Project Impact) between 1998 and 2002.

Past Performance of the State

Missouri's Hazard Mitigation Grant Program (HMGP) Administrative Plan, quarterly reporting system, and HMGP applications have all been used as models for other states as well as FEMA headquarters. The Hazard Mitigation Grant Program Administrative Plan developed by SEMA in 1995 was one of the first procedural plans ever developed that addressed additional elements not required by the Code of Federal Regulations. In addition, Missouri's standard HMGP buyout application and quarterly reports were requested by FEMA headquarters to use as the National Emergency Management Information System standard.

Adequate and Experienced Staff at Both the State and Regional Level

The Mitigation Section is part of SEMA's Logistics, Mitigation and Floodplain Management Branch. State hazard mitigation staff consists of two hazard mitigation specialists, one clerical assistant, and the state hazard mitigation officer. All positions are permanent, full-time, and are funded with state general revenue. In 2007, funding for an additional mitigation position was requested. This position, a planning specialist, would provide technical assistance to local jurisdictions regarding planning issues and mitigation project development.

The technical skills of all staff members are solid. To ensure consistency and smooth transitions, great care has been taken to ensure that all staff members are cross-trained and receive appropriate FEMA training. The Mitigation Section has directly administered over $100 million in hazard mitigation and unmet needs funding since 1993. All current staff members have received formal benefit-cost analysis training. Three staff members have taken the FEMA grant management and NEMIS training. All staff members have attended several all-hazard mitigation workshops or state hazard mitigation officer training.

Newly hired staff will receive direct training either from existing staff or through partnerships with other state hazard mitigation officers and will attend formal FEMA training as appropriate. See Chapter 6 for further descriptions of staff responsibilities.

Specific roles and responsibilities for coordinating and implementing the Hazard Mitigation Grant Program in Missouri are assigned to SEMA staff as follows:

State Hazard Mitigation Officer:

The governor's authorized representative (GAR) designates the state hazard mitigation officer (SHMO). The SHMO has overall management responsibility for the program and is the state official who is ultimately responsible for ensuring that the state properly carries out its Section 404 (Hazard Mitigation Grant Program) responsibilities subsequent to a presidential disaster declaration. In this regard, the SHMO monitors the activities of the mitigation specialists, other staff support, and the State Hazard Mitigation Team.

Hazard Mitigation Specialists:

The hazard mitigation specialists assist the SHMO in organizing, coordinating, implementing, and administering hazard mitigation projects, including planning projects and the promotion, direction, and evaluation of mitigation issues. The specialist accomplishes the necessary program work required of the state to deliver the Hazard Mitigation Grant Program (HMGP) to eligible subgrantees.

Other Staff Involvement:

The director (GAR), deputy director, Logistics, Mitigation and Floodplain Management Branch chief, Earthquake Program manager (who also has hazard mitigation specialist duties), and the Logistics, Mitigation and Floodplain Management Branch administrative assistant are also involved with the mitigation program and provide support as needed.

Responsibilities of the SHMO, hazard mitigation specialists, and others include, but are not limited to:

- Ensuring Missouri’s Hazard Mitigation Grant Program Administrative Plan is updated, outlining how the state will administer and implement the program during a disaster;
- Ensuring that the Missouri State Hazard Mitigation Plan is active, identifying potential hazard mitigation projects, and establishing priorities among those projects; and
- Coordinating with the federal hazard mitigation officer to determine the composition of the interagency hazard mitigation team or hazard mitigation survey team and its schedule of activities in estimating the amount of FEMA money available from the HMGP and in administering the program, including submitting required reports to FEMA.

Region’s Ability and Willingness to Provide Additional Resources and Training to the State

This is not applicable.

State and Regional Relationship

The relationship between the state and FEMA Region VII has always been maintained in an open, professional manner.

Expertise in the Area of Preparing Environmental Documentation and Conducting Benefit-Cost Analyses

History and a memorandum of agreement with the Missouri Department of Transportation are indicators of the commitment of SEMA and their state agency partners to be able to prepare environmental documentation and conduct benefit-cost analyses. This is further evidenced by the role of the Department of Natural Resources state historic preservation officer (SHPO) in

environmental documentation. The SHPO coordinates with SEMA on all mitigation projects to ensure that any and all historic preservation concerns are recognized and addressed.

Until recently, SEMA performed all benefit-cost analyses for all hazard mitigation grant applications. Since the 2004 plan, the RPCs and the local governments have all been offered training on FEMA's BCA software and processes primarily for the purpose of Pre-Disaster Mitigation grant applications. SEMA still provides technical assistance regarding BCAs, but only for communities that do not have the capability to do it themselves.

All current SEMA mitigation staff members have received formal FEMA benefit-cost training and use the software on a regular basis to keep knowledge and skills current.

State Commitment to Floodplain Management

Coordination of the National Flood Insurance Program was transferred from the Department of Natural Resources to SEMA in 1995. Over the last eleven years, there has been an enormous effort by state staff to bring heightened awareness and technical assistance to local communities. Training, joint seminars with the Flood Insurance Administration and an annual workshop have been institutionalized. A local guidebook and a quick reference manual were released and hailed a success by local communities and FEMA.

According to FEMA's Community Status Book, 21 additional communities have joined the National Flood Insurance Program since January of 2004. In January 2007, there were only 18 counties (their unincorporated areas), out of 114, that are not participating in the program.

In July of 1997, Executive Order 97-09 was signed by the lieutenant governor authorizing SEMA to issue permits for any state-owned or leased development in a special flood hazard area.

SEMA floodplain management staff consists of an engineer, two floodplain managers, one clerk, and a statewide coordinator.

Floodplain management enjoys vital day-to-day relationships with the statewide hazard mitigation efforts and staff. Perhaps the most profound change in the state's role in floodplain management and coordination is that state funding has increased over time.

State Use of the Hazard Mitigation Team to Prioritize and Select HMGP Applications and Ensure Coordination among Key State Functions

Although a formal organization or arrangement is not always present or used by Missouri to prioritize and select HMGP projects, it is erroneous to assume that such is carried out in a vacuum. The 1993, 1994, and 1995 buyout projects were selected, coordinated, and managed by a small committee appointed by the governor for this specific purpose. The wisdom in this approach can be found in the results. Six months after funding became available, all projects were approved and one project was completed.

Currently, smaller projects are coordinated with the agencies responsible for environmental approvals, partial funding, or other projects with similar objectives, stakeholders, or locations, such as the Departments of Economic Development, Conservation, Natural Resources, and Transportation; the U.S. Army Corps of Engineers; and others as the situation dictates. This practice will continue with a more formal body used in the event that large HMGP opportunities are presented.

Demonstrated Relationship between the State and Local Governments

Throughout the extensive buyout program and for all mitigation projects, the state has operated on a basic principle—centralized planning with decentralized execution. To the extent that local governments can manage projects, they are allowed to do so. However, compliance with established procedures, priorities, and “safe guard measures” is required. Local governments have been vocal in their enthusiastic support for this approach. SEMA is routinely told that they provide local governments with exactly what they need to be successful.

Commitment to Training by the State and FEMA

All current staff members have received formal benefit-cost analysis training. Three staff members have taken the FEMA grant management and NEMIS training. All staff members have attended several all-hazard mitigation workshops or state hazard mitigation officer training efforts.

Newly hired staff will receive direct training either from existing staff or through partnerships with other state hazard mitigation officers and will attend formal FEMA training as appropriate.

Training for local units of government before and following an HMGP award is ongoing. Formality depends on the needs of the community. Currently, SEMA offers annual training on basic mitigation planning, Pre-Disaster Mitigation grant applications, and using FEMA’s BCA software. Additional training is offered as new training or software modules are released by FEMA.

7.4 Assessment of Mitigation Actions

Requirement §201.5(b)(2) (iv):	The enhanced plan must document the system and strategy by which the state will conduct an assessment of the completed mitigation actions and include a record of the effectiveness (actual cost avoidance) of each mitigation action.

This section explains how the state assesses the effectiveness of mitigation projects, both pre- and postdisaster. Also explained is how SEMA has improved their ability to monitor and track each completed project and potential losses avoided since development of the original plan in 2004.

7.4.1 Annual Progress Assessment/Review of Mitigation Goals, Objectives, and Measures

In order for any program to remain effective, the goals and objectives of that program must be reviewed periodically. The Missouri State Hazard Mitigation Plan is reviewed annually by the Hazard Mitigation Planning Team. This provides the simplest, direct and ongoing methodology for assessing and reviewing mitigation goals, objectives, and actions. At a minimum, the review addresses the following issues:

- Are the established goals and objectives realistic? (Take into consideration available funding, staffing, and state/local capabilities, and the overall state mitigation strategy.)
- Has the state clearly explained the overall mitigation strategy to local governments?
- Are proposed mitigation projects evaluated based on how they help the state and/or local government meet their overall mitigation goals and objectives?
- How have approved mitigation projects complemented existing state and/or local government mitigation goals and objectives?
- Have completed mitigation projects generated the anticipated cost avoidance or other disaster reduction result?

In 2007, the HMPT reconsidered the validity of the goals and objectives of this mitigation plan and of the state mitigation program. This is detailed in Section 4.1 Hazard Mitigation Goals and Objectives.

The overall mitigation strategy is clearly communicated to local governments throughout the year and is an ongoing process. The strategy is explained through SEMA mitigation training and workshops (BCA, PDM, mitigation planning) and annual meetings of the Missouri Emergency Preparedness Association, the Missouri Floodplain and Stormwater Managers Association, and the Missouri Association of Councils of Governments.

In order to earn SEMA approval, mitigation projects must complement the overall mitigation strategy of the state as well as the applicable local government. This is included in the list of questions to help guide the distribution of mitigation project funds detailed in Section 5.3.2 Project Grants.

How SEMA determines whether or not completed mitigation projects generate the anticipated cost avoidance or other disaster reduction result is explained in Section 7.4.2 Postdisaster Progress Assessment/Review for Mitigation Goals, Objectives, and Measures.

Finally, the Logistics, Mitigation and Floodplain Management Branch of SEMA furthers this programmatic progress assessment through the ongoing tracking of:

- Mitigation activities during the past year;
- Mitigation grants in progress, including
  - Affected jurisdiction,

  - Brief description of the project,
  - Source of funding, and
  - Summary of project status (percent complete);
- Executed mitigation grant support contracts; and
- Floodplain management activities during the past year, including
  - NFIP statewide statistics and
  - NFIP training activities conducted.

All of the above information is captured in SEMA's fiscal year annual report.

It may be difficult to determine the actual cost avoidance and effectiveness of many mitigation projects during project development. Initially, the potential impact of mitigation projects and initiatives can only be estimated. However, based on past experience with similar projects, SEMA can make an educated determination as to the potential for success of the proposed mitigation project.

Based on the results of this information and the annual review, the state considers making adjustments to its goals, objectives, and actions to meet the current and future mitigation needs of the state and its local governments.

7.4.2 Postdisaster Progress Assessment/Review of Mitigation Goals, Objectives, and Measures

Following a hazard event, SEMA mitigation staff query local officials to document how mitigation actions instituted in the affected areas lessened the amount of damage or loss of life that could have resulted from the event. Local officials are also encouraged to contact SEMA whenever a project successfully reduces losses from a hazard event. This information, results, and conclusions, as well as findings from the annual review and report, are incorporated into mitigation success stories to aid in the assessment of the current and future goals, objectives, and actions. Over the next three years, SEMA will continue to develop processes to analyze successes.

This evaluation of mitigation project effectiveness (success) and future losses avoided was used to document the success of the Missouri buyout program. In simple terms, by removing a structure (family) from the flood hazard area, the potential threat to that family and the associated disaster assistance costs was reduced. For example, the flood of 1995 was significantly equal to the flood of 1993; however, the buyouts dramatically reduced the costs associated with the 1995 flood because the properties were no longer there. Following the 1993 floods, FEMA, SEMA, the Department of Economic Development, and local communities implemented more than 100 buyout projects covering more than 4,000 properties at a cost of approximately $100 million. The 1995 flood resulted in only three buyout projects for 149 properties at a cost of less than $5 million. The National Flood Insurance Program paid out approximately $56 million in claims for the 1993 floods, but only a little over $500,000

following the 1995 floods. SEMA has published success stories like these in *Stemming the Tide of Flood Losses* and provides success stories to FEMA and to organizations like the Association of State Floodplain Managers to educate the public about the effectiveness of mitigation.

A thorough and realistic evaluation of the benefits of a mitigation project may be delayed until the area of the project is impacted by another disaster. The lack of realized benefits from a completed mitigation project may result in the disapproval or modification of similar projects in the future. At the same time, mitigation projects that have proven their worth may be repeated in other areas of the state.

SEMA continues to make progress in using GIS and GPS technology to further refine the tracking and evaluation of mitigation projects to improve the accuracy of future assessments. Since 2002, SEMA has been using latitude and longitude coordinates, obtained through GPS, to mark and map lots acquired through buyout programs. This helps monitor compliance with open space deed restrictions. SEMA also requires communities participating in the buyout program to implement procedures for monitoring the open space that has resulted from these projects to ensure that at risk areas are not inappropriately redeveloped, resulting in the reduction of the program's effectiveness. SEMA follows up on this local government responsibility by sending an annual letter to buyout communities reminding them of their open space maintenance requirements.

Efforts to map past buyouts prior to 2002 have proven difficult because communities have combined parcels and lots into combined open spaces, streets and addresses no longer exist (as a result of the buyouts), and legal property descriptions are not accurate enough to pinpoint precise locations. SEMA is partnering with the University of Missouri to address these issues and continue progress on the database. The database will be used to track and measure the effectiveness of the mitigation actions funded and ensure compliance with deed restrictions.

SEMA continues to work on a system to document cost avoidance to further demonstrate postdisaster mitigation progress. Cost avoidance is generated when a completed project demonstrates its success (i.e., a hazard event occurs in the area of the project and losses are avoided as a result of the project). The only mitigation projects completed and closed since 2004 were one safe room, low water crossings, buyouts, and electric line burial. Although disasters have occurred in Missouri in the past three years (see Table 7.2), none of these disasters impacted past project sites, thus it is not possible to determine cost avoidance at this time. However, in future plan updates, cost avoidance will be reevaluated.

Table 7.2. Major Disaster and Emergency Declarations in Missouri since 2004 Plan

Declaration Date	Disaster No.	Incident Type
June 11, 2004	DR 1524	Severe Storms, Tornadoes, and Flooding
September 10, 2005	EM 3232	Hurricane Katrina Evacuation
March 10, 2006	DR 1631	Severe Storms, Tornadoes, and Flooding
April 5, 2006	DR 1635	Severe Storms, Tornadoes, and Flooding

Declaration Date	Disaster No.	Incident Type
July 21, 2006	EM 3267	Severe Storms
November 2, 2006*	DR 1667	Severe Storms
December 29, 2006	DR 1673	Severe Winter Storms
January 15, 2007	DR 1676	Winter Storms and Flooding

Source: Federal Emergency Management Agency
Note:
*Declaration was for incident in July 2006 and approved November 2, 2006

FEMA Region VII is in the process of doing a cost avoidance project through the Hazard Mitigation Technical Assistance Program. SEMA will evaluate the methodologies and procedures used in this project to determine the applicability of the assessment methods to Missouri's mitigation projects.

A variety of methods can be used to calculate the long-term economic benefits of structural mitigation projects. The HAZUS-MH flood and earthquake modules, if populated with local data, can estimate the economic impacts of certain storm events on a census-block level. It may be possible to then evaluate the benefits. Where benefit-cost analysis reports are available for projects, data from these reports can be used to estimate cost savings from future floods.

Flooding is still the priority in Missouri, and the state is aware of other disasters that can and will occur. The assessment process will be linked to a multi-hazard approach. The strategy for assessing all types of mitigation projects for cost avoidance will be based on the same type of strategy used for flood. The intent of the state is that any database developed to demonstrate cost avoidance will be updated to incorporate tracking of all mitigation projects, where the data is available.

When staffing and funding is available, a database will be used to track cost avoidance. Data fields can be tailored to the hazard but could include property location, mitigation measure, mitigation date, project cost, date of disaster, hazard extent (e.g., flood depth, tornado path extent), damage percent, and damage avoided (calculated by depth damage function, property damage avoided, and/or deaths or injuries averted, where possible).

7.5 Effective Use of Available Mitigation Funding

Requirement §201.5(b)(3):	The enhanced plan must demonstrate that the state effectively uses existing mitigation programs to achieve its mitigation goals.

This section identifies some general and specific hazard mitigation projects. They are examples of the types of projects that have made, and continue to make, Missouri's hazard mitigation program effective and successful. These projects, and others like them, have been approved in the past based on their ability to achieve some, or all, of the state's mitigation goals and objectives. Because of this demonstrated success, similar projects are likely to be approved in the

future. Table 7.3 summarizes the federal funds received by the state for mitigation between 2004 and June 2007.

Table 7.3. Missouri Mitigation Funding, 2004 to June 2007

Grant Type	Eligible Amount ($)	Received Amount ($)	Obligated Amount ($)
Flood Mitigation Assistance 2004	280,500	280,500	280,500
Flood Mitigation Assistance 2005	208,260	33,870	33,870
Flood Mitigation Assistance 2006	278,200	278,200	278,200
Hazard Mitigation Grant Program 1631	1,290,726	1,136,850	1,136,850
Hazard Mitigation Grant Program 1635	4,210,525	3,923,692	3,923,692
Hazard Mitigation Grant Program 1667	128,676	0	0
Hazard Mitigation Grant Program 1673	1,275,000	0	0
Hazard Mitigation Grant Program 1676	21,771,250	0	0
Hazard Mitigation Grant Program 1708	2,010,838	0	0
Pre-Disaster Mitigation 2005	19,231,239	19,231,239	19,231,239
Pre-Disaster Mitigation 2006	6,834,9780	6,834,980	6,834,980
Pre-Disaster Mitigation 2007	14,316,226	14,316,226	14,316,226
Repetitive Flood Claims	n/a	n/a	n/a
Severe Repetitive Loss	n/a	n/a	n/a
Totals	**71,836,421**	**46,035,558**	**46,035,558**

Notes:
The Repetitive Flood Claims program was available only once during this time period.
The Severe Repetitive Loss program was not available during this time period. The first grant guidance was released on January 14, 2008.
Hazard Mitigation Grant Program funding was held awaiting FEMA's publication of the Tornado Safe Room Funding Policy, which was released on March 7, 2008.

Taking advantage of the Flood Mitigation Assistance Program has been an annual challenge due to the limited annual allocation. However, communities with eligible small mitigation projects have been successful at fitting their projects into the funding provided. This has resulted in the completion of one elevation project and three buyout projects during the given timeframe.

The state has experienced an inordinate number of federally declared disasters since 2004. As a result, a large amount of money is available to the state from the Hazard Mitigation Grant Program (HMGP). At the time of this plan update, these funds were not yet obligated to specific projects. This is partly because the state had been waiting since January 2007 for the release of a FEMA policy review for the funding of tornado safe rooms. The state has held back HMGP funds in the hopes of funding a number of safe room projects.

The state has been very successful at competing for Pre-Disaster Mitigation funds. This funding represents several projects, including buyouts, safe rooms, low water crossings, a bridge, and electric line burials, and 2 plans, as discussed in Section 4.4.4 Review and Progress of Mitigation Actions.

It should be noted that the Repetitive Flood Claims program was available only once during the given time period. The state had the opportunity to submit one buyout application under this grant, but it was unsuccessful. The Severe Repetitive Loss program was not available during this time period. The first grant guidance was released on January 14, 2008.

As a result of the successes achieved through past and present mitigation funding sources and public-private partnerships, SEMA remains committed to continuing its efforts to encourage leveraging of available funds and establish partnerships for project leadership, implementation, and maintenance. The following tables from Section 4.4.1 Mitigation Actions reiterate the effectiveness of actions funded through SEMA and how they relate to the state's mitigation goals and the Emergency Management Accreditation Program's (EMAP) mitigation standards.

Table 7.4. Missouri Mitigation Action Categories Strategy Overview

Action Category	Priority	Responsible Agency for Implementation	Hazards Addressed	Link to Local Plans, Actions, and Assistance	Effective-Ness*	EMAP Mitigation Consider-ations
M1—State and Local Hazard Mitigation Plans	High	SEMA/RPCs/ local jurisdictions	All	Continued use of RPCs	High	1,2,3,4,5,6,7,8 9,10,11,12
M2—NFIP Floodplain Management and Community Rating System	High	SEMA/local jurisdictions	Flood	Community assistance visits, workshops	High	1,2,3,4,5,6, 7,8,9,12
M3—Voluntary Property Acquisitions (Flood Buyout)	High	SEMA/local jurisdictions	Flood	Projects identified in local plans	High	2,3,6
M4—Voluntary Elevation, Relocation, Floodproofing	High	SEMA/local jurisdictions	Flood	Projects identified in local plans	High	1,2,3,6,9
M5—Tornado Safe Rooms	High	SEMA/local jurisdictions	Tornado	Projects identified in local plans	Moderate	1,3,6,9

Action Category	Priority	Responsible Agency for Implementation	Hazards Addressed	Link to Local Plans, Actions, and Assistance	Effective-Ness*	EMAP Mitigation Consider-ations
M6—Earthquake/ High Wind Structural Mitigation Projects	Medium	SEMA/MoDOT	Earthquake Tornado	Projects identified in local plans	High	1,3,9
M7—Earthquake/High Wind Nonstructural Mitigation Projects	Medium	SEMA/local jurisdictions	Earthquake Tornado	Projects identified in local plans	High	1,3,9
M8—Structural/ Infrastructure Mitigation Projects (including Public Assistance projects)	Medium	SEMA/MoDOT/ local jurisdictions	Flood	Projects identified in local plans	High	1,2,3,5,6,7,8,9, 11
M9—Buried Electric Service Lines	Low	Local jurisdictions/ certain utility providers	Multiple	Projects identified in local plans	Moderate	3,4,6,9
M10—State 5% Initiative Projects	Low	SEMA/local jurisdictions	Multiple	Projects identified in local plans, difficult to measure cost-effectiveness	Moderate	1,5,6,10,11,12
M11—Technical Assistance	Low	SEMA and other agencies	Multiple	Needs identified in local plan capability assessments	Moderate	1,2,3,4,5,6,7,8 9,10,11,12

Action Category	Priority	Responsible Agency for Implementation	Hazards Addressed	Link to Local Plans, Actions, and Assistance	Effective-Ness*	EMAP Mitigation Consider-ations

Note:
*High denotes action mitigates impacts to life safety and property, moderate denotes action mitigates impacts to life safety only or property only
EMAP mitigation considerations:
1) The use of applicable building construction standards
2) Hazard avoidance through appropriate land use practices
3) Relocation, retrofitting, or removal of structures at risk
4) Removal or elimination of the hazard
5) Reduction or limitation of the amount or size of the hazard
6) Segregation of the hazard from that which is to be protected
7) Modification of the basic characteristics of the hazard
8) Control the rate of release of the hazard
9) Provision of protective systems or equipment for both cyber and physical risks
10) Establishment of hazard warning and communication procedures
11) Redundancy or duplication of essential personnel, critical systems, equipment, information, operations, or materials.
12) Educating the public about mitigation (additional measure added by SEMA—not part of EMAP)

Table 7.5. Mitigation Action Categories and Goals Crosswalk

Objectives	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
Goal 1: Improve the Protection of Human Life, Health, and Safety											
Objective 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 3	✓	✓			✓	✓	✓			✓	✓
Objective 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Goal 2: Improve the Protection of Continuity of Government and Essential Services Safety											
Objective 1	✓	✓			✓	✓	✓	✓	✓	✓	✓
Objective 2	✓	✓			✓	✓	✓	✓	✓	✓	✓
Objective 3	✓	✓			✓	✓	✓	✓	✓	✓	✓
Objective 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 5	✓	✓			✓	✓	✓	✓	✓	✓	✓
Goal 3: Improve the Protection of Public and Private Property											
Objective 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 3	✓	✓			✓	✓	✓			✓	✓
Objective 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Goal 4: Improve the Protection of Community Tranquility											
Objective 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objective 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: Objectives can be found in Section 4.1 Hazard Mitigation Goals and Objectives

The following activities are illustrative of the general types of projects that have been approved as part of the state's mitigation program. This list is not all-inclusive; however, it does demonstrate the effective use of available mitigation funding and how SEMA has used FEMA and non-FEMA funding to support mitigation in Missouri.

Local Hazard Mitigation Plan Development (M1)

Mitigation funds have been used to help communities throughout the state develop hazard mitigation plans. As part of this process, these communities have developed public-private partnerships that have expanded their work into other mitigation-related activities. As a result of these initial planning activities, communities are more aware of the benefits of an active mitigation program and have instituted mitigation projects with their own funds.

The local mitigation planning project supports all of the goals of this plan by contributing to the development of local plans that complement the state plan and serving as the foundation for FEMA hazard mitigation grant eligibility (see Tables 7.3 and 7.4). Historically, local hazard

mitigation plans in Missouri have been funded through the Hazard Mitigation Grant Program and the Pre-Disaster Mitigation program with local matching funds and/or in-kind services.

Preparation/Updating of Floodplain Maps (M2 and M11)

Funds from a variety of programs have been used to develop flood maps for previously unmapped areas and to revise/update older existing maps. This initiative will enable more communities in the state to join the National Flood Insurance Program (NFIP). As a result, more individuals, families, and businesses will be able to get insurance to cover future flood-related losses. In Missouri, SEMA is participating in FEMA's Map Modernization program and in early 2007 was in the process of converting and/or updating flood maps in 39 counties.

The Missouri Map Modernization effort supports all of the goals and objectives of this plan as indicated in Tables 7.3 and 7.4. The program also supports the state's mitigation strategy for ensuring continued effective use of resources by demonstrating how partnerships with other state and local agencies are used to leverage funding. In Missouri, three cities, two counties, and SEMA participate in FEMA's Cooperating Technical Partners (CTP) Program. CTP partnerships are established with NFIP participants that have both the interest and capability to become more active in the FEMA flood hazard mapping program by collaborating to maintain up-to-date flood hazard maps and other flood hazard information.

Acquisition of Primary Residences in Flood-Prone Areas (M3)

The state has previously, and most likely will continue to, make the acquisition of primary residences in flood-prone areas a top priority. Hazard Mitigation Grant Program funds from previous Missouri disasters have been used to fund this extremely successful program. The Missouri Community Buyout Program was recognized as a model for the nation following the devastating 1993 floods.

This program removed families from harm's way. By doing so, it eliminated the threat of flooding and the associated financial and emotional hardship on those families that participated in the program; reduced the cost of future disasters to the federal, state, and local government; and provided the participating community with open space to develop parks for the entire community to enjoy. It also has reduced impacts on local first responders, who have fewer life safety emergencies to handle during floods.

Since the 1993 flood, this buyout program has continued and truly demonstrates how Missouri has effectively used available mitigation funding programs and packaged these mitigation funds with funds from non-FEMA sources. Appendix D Past Mitigation Projects illustrates that mitigation funds have come from FEMA's Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and the Pre-Disaster Mitigation program over multiple annual budget and have stemmed from multiple disasters. The FEMA funds have been matched, packaged, and combined with Community Development Block Grants (including supplemental appropriations for Unmet Needs), state general revenue, and local government funds. Missouri applied for

Repetitive Flood Claims funding in 2007 and will again in the future. Missouri also intends to apply for funding from the Severe Repetitive Loss program, but as of this plan update, guidance had not yet been issued.

The buyout program supports the goals and objectives of this plan as indicated in Tables 7.3 and 7.4. The program also supports the state's mitigation strategy for ensuring continued effective use of resources by demonstrating how partnerships with other state and local agencies can be used to leverage funding.

Tornado Shelters (M5)

In Missouri, only flood mitigation projects are prioritized ahead of projects that mitigate tornadoes and high winds. During the 2007 plan update, the importance of tornado shelters among the action categories was elevated from M6 to M5 due to a number of recent tornado events and an increased interest in tornado shelters. Between 2002 and 2006 twenty-two tornado shelters were funded in Missouri, primarily with PDM funding. Tornado shelters have proven to protect people from tornadoes and high winds when built to FEMA construction standards. Projects include safe rooms in homes that protect individual families as well as large-scale community shelters, which often meet multiple community objectives (e.g., serving as both a school gymnasium and a shelter).

The funding of tornado shelters supports the goals and objectives of this plan as indicated in Tables 7.3 and 7.4. The program also supports the state's mitigation strategy for ensuring continued effective use of resources by demonstrating how partnerships with other state and local agencies can be used to leverage funding.

Increased Weather Radio Coverage (M10)

Through SEMA, and in cooperation with the National Weather Service (NWS), local governments, electric cooperatives, and private enterprises, the state has significantly increased statewide coverage of the National Oceanic and Atmospheric Administration (NOAA) Weather Radio (NWR) All Hazards. As of early 2007, Missouri had nearly 95 percent geographic coverage using mostly private, donated tower space for the transmitters. The residents of Missouri are the primary beneficiaries of the efforts of these agencies and businesses as the warnings provided by this system will give them the time they need to protect their families and their property in the event of severe weather.

The NWR coverage improvements support the goals and objectives of this plan as indicated in Tables 7.3 and 7.4. The program supports the state's mitigation strategy for ensuring continued effective use of resources by demonstrating how partnerships (with the NWS, local governments, electric cooperatives, and private enterprises) can be used to leverage funding.

Public Outreach (M10 and M11)

SEMA also makes a considerable effort to educate the public, local officials, government officials, schools, private associations, and businesses about the value and importance of mitigation programs. SEMA offers mitigation workshops, participates in public forums, provides one-on-one counseling, presents at conferences, provides written materials, develops guidebooks and manuals, publishes success stories, sends out press releases, offers information on the Internet, and provides training materials to local emergency managers, earthquake program partners, floodplain managers, and businesses.

SEMA's public outreach efforts support all the goals of this plan, as increased public awareness is an objective under every goal (see Tables 7.3 and 7.4 and Section 4.1 Hazard Mitigation Goals and Objectives). These efforts also support the state's mitigation strategy for ensuring continued effective use of resources through a wide array of partnerships (common partnerships for public outreach include public and private radio and television stations, public and private school organizations, and service organizations (e.g., Lions, Rotary, and Elks clubs) and volunteer organizations (American Red Cross).

Pre-Disaster Mitigation Grant Application Assistance (M11)

As documented in Section 4.4.4 Review and Progress of Mitigation Actions, Missouri has successfully secured funding for local mitigation plans and projects and state mitigation planning funds from the annual, nationally competitive Pre-Disaster Mitigation (PDM) grant program since 2002. One of the reasons for this success is the hands on technical assistance that SEMA provides to subapplicants in their grant applications and benefit-cost analyses. This has been provided through three contractor supported PDM grant workshops for fiscal years 2005, 2006, and 2007.

This assistance supports all the goals of this plan by educating eligible state, local, and nonprofit entities as to how they can secure funding for mitigation planning and projects. It also supports the state's mitigation strategy for ensuring continued effective use of resources by educating subgrantees about the process (as well as the state goals and objectives) to maximize the amount of PDM funding granted to Missouri. Projects are screened during the application process to determine if they align with local and state mitigation goals.

Other Mitigation Actions

From time to time, other types of actions have been warranted if proven to be cost-effective solutions to problems. For example, when enough damage was documented, it was possible to win approval to bury electric service lines from the street to the meter on residences to mitigate the adverse effects of severe weather (M9). These projects have been required to fulfill all the requirements for flood mitigation projects and possibly have had other additional requirements depending on the nature of the project.

Other actions implemented or obligated between 2002 and 2006 are flood elevations (M4), bridge replacements (M8), low water crossings (M8), streambank stabilizations (M2 and M10), water supply interconnects (M8), and high wind retrofits (M6). The Missouri Department of Transportation designs new bridges and retrofits old bridges, including several in St. Louis, to resist seismic impacts (M6 and M8). To see how these actions meet the goals and objectives of the state, see Tables 7.3 and 7.4. More information about these activities can be found in Section 4.4 Mitigation Actions.

7.5.1 Mitigation Success

The state mitigation program encourages and motivates state and local government agencies, as well as the private sector and the general public, to mitigate hazards and establishes priorities for hazard mitigation programs in all areas of the state. To establish these priorities, the Hazard Mitigation Planning Team reviewed existing state statutes, ongoing mitigation initiatives, proposed mitigation initiatives/projects, and completed mitigation projects. The review of completed mitigation projects focused on the projects' overall success and contribution toward meeting the goals and objectives of the state and applicable local mitigation program.

Following are some examples of successful mitigation programs and projects. This list is not all-inclusive, but does include the efforts that have been deemed the most successful and/or beneficial to the overall mitigation program.

The State Hazard Mitigation Program

The state, through SEMA, has instituted an effective and comprehensive all-hazard mitigation program. Through the wise use of available federal and state funds (e.g., Hazard Mitigation Grant Program, Public Assistance, Unmet Needs, Project Impact, Pre-Disaster Mitigation, Flood Mitigation Assistance, Community Development Block Grants, Department of Natural Resources Stormwater Grants, Natural Resources Conservation Service, etc.) the state has been able to successfully mitigate many areas against the devastating effects of future disasters.

SEMA has developed a hazard mitigation planning guidebook for local officials and continually offers assistance to any community desiring to develop a plan. Hazard mitigation planning is a component of the state's disaster resistant community effort.

History and a recent memorandum of agreement with the Missouri Department of Transportation are indicators of SEMA's commitment to be able to prepare environmental documentation and conduct benefit-cost analyses. Historically, SEMA has performed or reviewed all benefit-cost analyses for hazard mitigation grant applications and successfully trained local jurisdictions to do them. All current mitigation staff members have received formal FEMA benefit-cost training and use the software on a regular basis to keep knowledge and skills current.

During the 1993 Midwest floods, an interagency hazard mitigation team (IHMT) was formed. This team was composed of representatives from FEMA, SEMA, and various state

agencies/departments (Governor’s Office, Department of Economic Development, Department of Natural Resources, Department of Transportation, and others. The 1993, 1994, and 1995 buyout projects were selected, coordinated, and managed by a small committee appointed by the governor for this specific purpose. The wisdom in this approach can be found in the results. Only six months after hazard mitigation funding became available, all projects were approved.

This IHMT would later become the Hazard Mitigation Project Coordinating Group, now the HMPT. While the name of this entity changed, its purpose remains the same. Following a significant disaster, hazard mitigation projects are coordinated through the HMPT. This coordination is primarily with representatives from the Department of Economic Development Community Development Block Grant section, the Missouri Department of Transportation, the Department of Natural Resources Historic Preservation office, and the U.S. Army Corps of Engineers. Other state and federal agencies may be added to this group as the situation and mitigation issue dictates. This practice will continue as hazard mitigation opportunities arise.

The mitigation process and the state’s mitigation initiatives are ongoing. SEMA’s mitigation staff, in conjunction with other state and local agencies, continues to look for new opportunities and funding sources to expand existing mitigation initiatives and develop new ones. The primary focus for the use of disaster-related Hazard Mitigation Grant Program funds has been the flood buyout program.

The state also has an effective and proactive floodplain management program. Personnel from the Logistics, Mitigation and Floodplain Management Branch of SEMA are continually conducting assistance visits, trainings, and site inspections in communities throughout the state. These efforts ensure that local government, private enterprises, and the citizens of the state are aware of the benefits of participating in the National Flood Insurance Program, among other things.

As a result of the state’s mitigation program, local governments and private industries have formed partnerships to make the state and their communities and residents safer and more prepared for the next potential disaster. Their actions will help ensure that future disasters have less of an impact on lives, property, and infrastructure in their communities and the state.

Missouri Community Buyout Program

In the aftermath of the summer of 1993 flood, the state launched an unprecedented statewide hazard mitigation effort in the form of the Community Buyout Program. This was a voluntary program designed to acquire residential properties in the floodplain and move residents out of harm’s way. The buyout program utilized a mix of federal funds, including funds from the Hazard Mitigation Grant Program, Public Assistance, and Missouri Community Development Block Grants. Then-Governor Mel Carnahan conservatively estimated the buyout program would save Missouri an estimated $200 million in flood fighting costs, Individual Assistance, and flood insurance claims over the next 20 years.

But, no one could predict Missouri would have the opportunity to test the buyout's effectiveness as quickly as it did when the spring 1995 flood, the third worst flood on record in many places, struck. Due to the buyout program, there were some 2,000 families no longer living in the floodplain. Removing these repetitive loss properties from harm's way saved millions in disaster assistance and emergency protective measures statewide.

Participating buyout communities were able to focus their efforts on the flood response. They did not have to use their precious resources on evacuating residents or sandbagging structures to save private property in the floodplain. Likewise, claims for flood insurance and applications for assistance, such as Small Business Administration and Individual and Family Grant (IFG) Program loans, were minimized.

The flood of 1995 was significantly equal to the flood of 1993 in the majority of communities that undertook a flood buyout program after the 1993 flood. The cost of human suffering was dramatically reduced in 1995, however, thanks to the buyout program and the associated demolition of about two-thirds of the flood-prone homes after the flood of 1993. This was because fewer people were in harm's way during the flood of 1995, thanks to Missouri's highly successful buyout program. Flood insurance payments paid out on flood buyout properties, more than $22.6 million for the 1993 and 1995 flood events, are flood payments that will never be paid out again.

The flood of May 2007 affected Missouri just before this plan went to press for the 2007 update. This flood also drew parallels to the 1993 flood, causing significant damage along the Missouri River, and generated more success stories for the buyout program. In one example, 17 properties had been acquired in the City of Tracy for approximately $450,000. In some areas of Tracy, recent water levels exceed those of the 1993 flood. Had they not been removed, the 17 homes would have been inundated and cost the city and homeowners hundreds of thousands of dollars. Many more success stories are likely to be generated from this event.

Table 7.6 highlights some of the key data relating to the success of the Missouri buyout program. It provides data comparing the buyout programs for the 1993 and the 1995 disasters in Missouri. The table provides a good comparison to highlight the overall success of the Missouri buyout program.

Table 7.6. Missouri's Buyout Success Story

	Total	1993	1995
Total Number of Buyout Projects	48	45	3
Number of Parcels Acquired*	4,193	4,044	149
Hazard Mitigation Grant to State**	$32.1 Million	$30.0 Million	$2.1 Million
Total Cost of Buyout Projects	$59.1 Million	$56.8 Million	$2.3 Million
Total Flood Insurance Claims Paid***	$22.7 Million	$22.1 Million	$563,393.00
SBA Loans Repaid (45%)	$5.7 Million	$5.4 Million	$321,542.00
Property Acquired: (Fair Market Value)****	$78.1 Million	$75.2 Million	$2.9 Million

Source: State Emergency Management Agency
Notes:
*Missouri only received $2.1 million in HMGP funds in 1995 as compared to $30 million after the 1993 flood.
**Through local governments, the Missouri was able to acquire 4,044 properties after the flood of 1993 for roughly $56.8 million. This is an average cost of $14,045. Although the properties had an average preflood fair market value of $18,500, because of flood payments paid prior to closing and deducted from the preflood value, the cost to acquire flooded properties was considerably less to the state.
***Small Business Administration (SBA)—The flood claims paid out on property acquired through the buyout in 1993 was more than $22.1 million. Only $563,393 was paid out in 1995 on the homes that were eventually acquired after the 1995 flood. Additional assistance of more than $4 million was also paid by FEMA to property owners participating in the buyout. Again, these payments will NEVER be paid again.
****Of the more than $1.9 million in SBA loans paid out on flood-damaged property, $5.4 million was repaid by property owners at the time of the buyout closing. In 1995, 100 percent of SBA loans paid out on flood-damaged property were repaid at the time of closing.

Since the 1993 floods, over 4,000 primary residences have been acquired through the buyout program. This voluntary program has allowed families in flood-prone areas to relocate out of harm's way and reduced disaster-related costs. The acquired properties were then placed in public ownership with deed restrictions that ensure that future use of these lands will not put the lives of Missouri residents at risk from flood disasters. Appendix D Past Mitigation Projects contains Community Buyout Program statistics through fiscal year 2006.

Some communities have continued this program by using local funds to acquire flood-prone properties. This is a clear example of the impact of advertising mitigation success stories. Because of the success of this program, the acquisition of flood-prone structures continues to be a priority for the use of hazard mitigation funds available to the state.

Local Mitigation Planning Project

This project was established to develop local hazard mitigation plans that meet the requirements of the Disaster Mitigation Act of 2000. Funding for this project came from the 7 percent planning funds available as part of the Hazard Mitigation Grant Program disbursements from two disasters in 2002 (DR 1403 and DR 1412) and one in 2003 (DR 1463) and Pre-Disaster Mitigation funds from fiscal years 2002, 2003, and 2005. This project involved Regional Planning Commissions and Councils of Government throughout the state, local communities, business and industry, and concerned private citizens in the mitigation planning process. As of early 2007, 94 percent of Missouri's population was covered by a FEMA-approved local

mitigation plan (94 of 115 counties). The success of this effort is documented in more detail in Chapter 5 Coordination of Local Mitigation Planning.

National Flood Insurance Program

In Missouri, the National Flood Insurance Program (NFIP) has shown remarkable progress over time. When SEMA took responsibility for administration of the state's floodplain management program in 1995, there were 523 jurisdictions in the National Flood Insurance Program. As of January 2007, there were 591 participating jurisdictions: 584 communities in the regular program and 7 communities in the emergency program. All the participating communities have established local floodplain management ordinances to help them administer the program.

There were 138 jurisdictions in Missouri that were not in the National Flood Insurance Program (NFIP) that had hazard areas identified. Twenty-seven of those 138 jurisdictions had their hazards areas identified for less than one year, a reflection of the new mapping initiatives taking place in Missouri, and 13 were suspended. The locations of participating and nonparticipating communities are mapped by county in Figures 7.1 and 7.2, respectively.

Figure 7.1. Missouri Communities Participating in NFIP

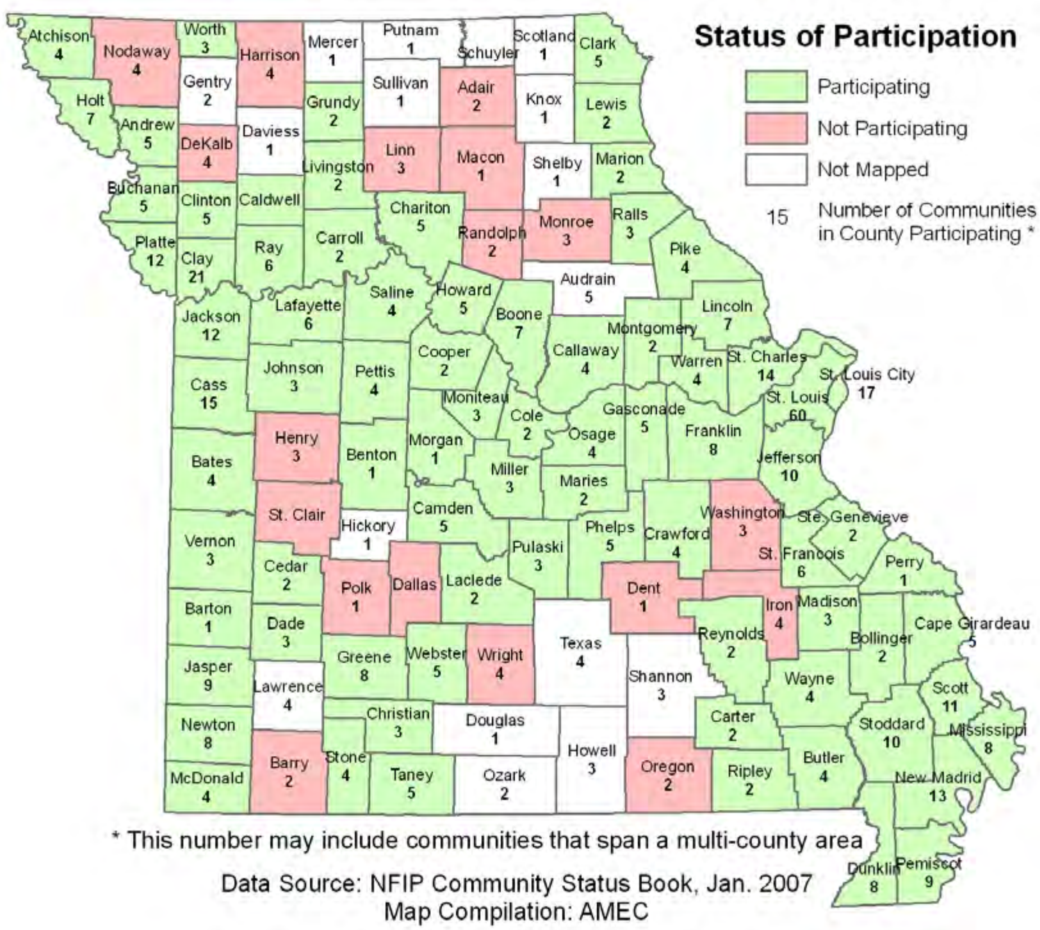
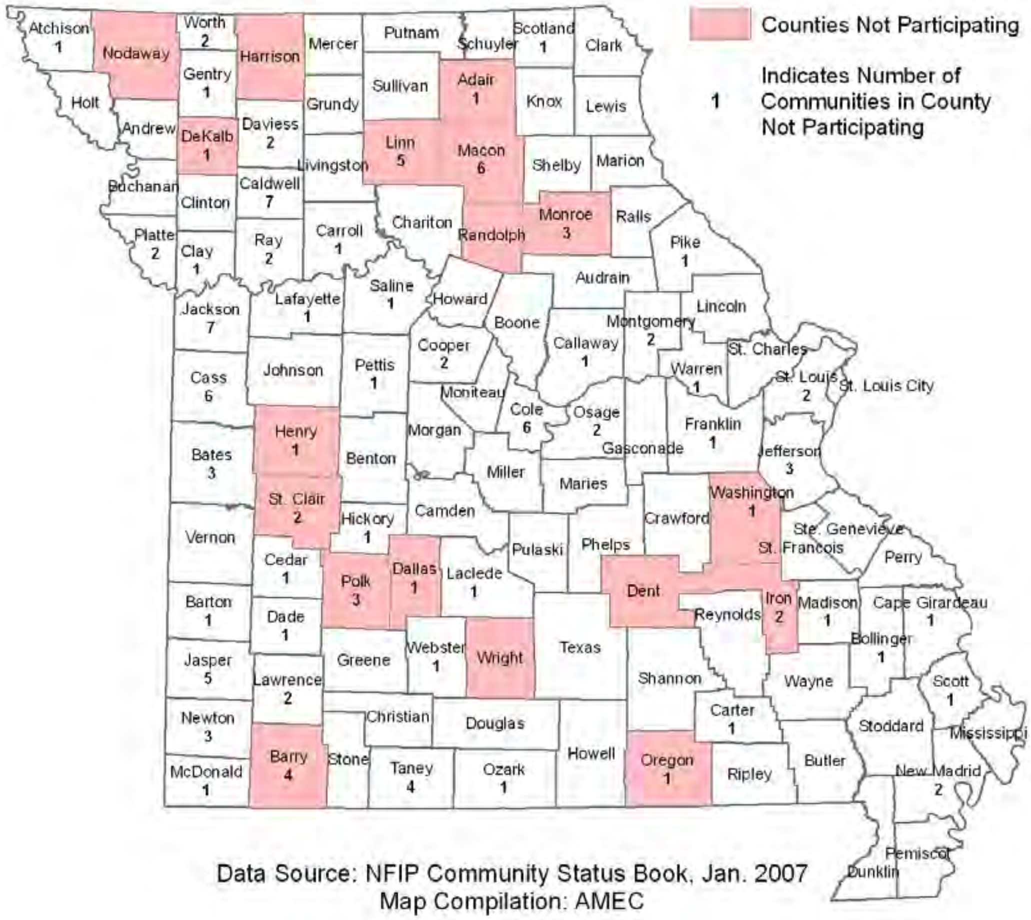


Figure 7.2. Missouri Communities Mapped but Not Participating in NFIP



The state has several floodplain mapping initiatives in progress. Missouri is currently in the map modernization process that will produce digital flood insurance rate maps for 39 counties by 2008. Funding for this mapping initiative came from a variety of federal, state, and local sources.

SEMA's Logistics, Mitigation and Floodplain Management Branch conducts NFIP training. In fiscal year 2006, training included:

- Nine NFIP classes for 481 insurance agents, land surveyors, real estate agents, real estate appraisers, and building code officials;
- Three Advanced NFIP Workshops for 89 local officials and NFIP administrators;
- Two Substantial Damage Workshops for 35 local officials and NFIP administrators; and
- Three Letter of Map Change Workshops for 64 engineers, surveyors, and local officials.

In fiscal year 2006, SEMA also conducted three Certified Floodplain Manager exams, which certified 16 new CFMs bringing the total of CFMs in Missouri to 79, hosted the Missouri

Association of Floodplain and Stormwater Managers Association, and attended the National Association of State Floodplain Managers conference.

Department of Natural Resources Stormwater Improvements

In 2001, the Missouri Department of Natural Resources (DNR) awarded more than $9.9 million to 46 Missouri communities for stormwater improvements. Of these 46 communities, 7 of them had populations of 3,000 or less. Funding for these grants came from bond issues approved by Missouri voters in 1988 and 1998 for improvements to stormwater, wastewater treatment, and public drinking water systems.

Types of projects approved by DNR included, but were not limited to:

- Drainage modifications to prevent pooling water, reduce streambank erosion, reduce localized flooding, and improve discharge water quality,
- Buyout and demolition of flood-prone homes,
- Replacement of undersized drainage systems to prevent flooding of houses and streets,
- Channel stabilization and drainage improvement,
- Modification of existing detention basin outlet for better storage capacity and to help avert downstream flooding,
- Development of city- and countywide stormwater management plans,
- Construction of stormwater collection and control systems,
- Combinations of biostabilization measures and upstream detention to alleviate existing erosion and to prevent future channel degradation based on anticipated future development conditions, and
- Construction of new storm sewer systems.

Reservoirs, Levees, and Flood Walls

During the Great Flood of 1993, flood damage reduction structures prevented an estimated $19.1 billion in potential additional damage, according to the May 26, 1994, *Draft Report of the Interagency Floodplain Management Review Committee*. Of that, it is estimated that at least $11.5 billion damage was prevented along the Missouri River: $7.4 billion was attributed to management of floodwater stored in reservoirs and $4.1 billion was attributed to levees. Reservoirs, levees, and flood walls prevented damage of approximately $5.6 billion in Kansas City.

Another study, conducted by a former U.S. Army Corps of Engineers (Corps) District engineer, estimated flood damage in the St. Louis district of the Corps at $1.4 billion. At the same time, the study estimated damage prevented by federal flood damage reduction efforts at $5.4 billion. Thus, an 80 percent reduction in potential damage was achieved in the St. Louis Corps district.

National Oceanic and Atmospheric Administration Weather Radio All Hazards

The National Oceanic and Atmospheric Administration (NOAA) Weather Radio All Hazards (NWR) is an all-hazards public warning system that broadcasts forecasts, warnings, and emergency information 24 hours a day. The National Weather Service has responsibility for the NWR. Tone alert radios receive the broadcasts and can be programmed to sound when severe weather watches, warnings, or other critical information is broadcast. They are designed to automatically sound when warnings are issued.

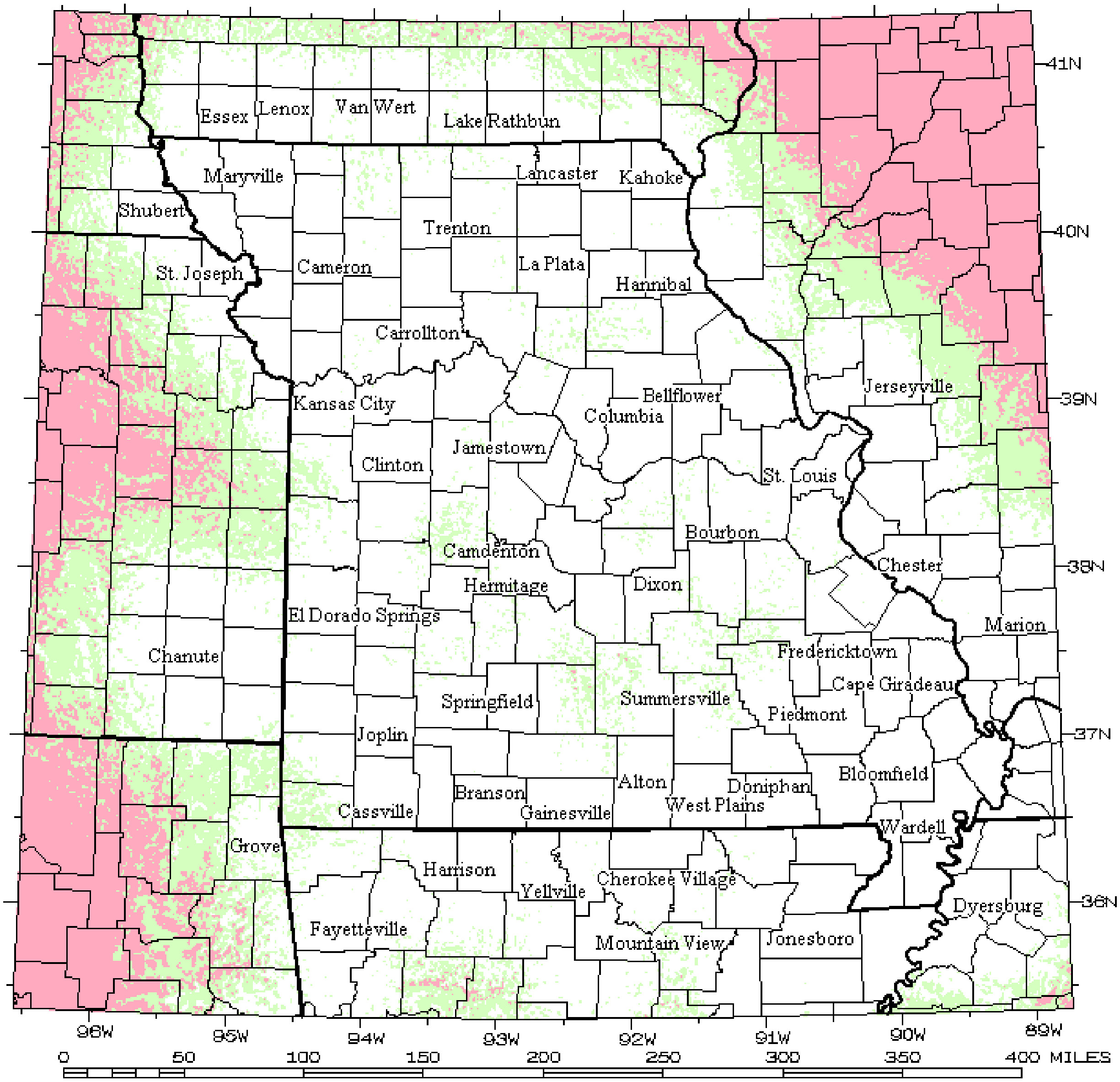
The NWR project increased the number of NOAA weather warning transmitters in Missouri from 10 in 1998 to 34 in 2007 (See Table 7.7). As of early 2007, 95 percent of the state could receive NWR broadcasts (see Figure 7.3). This success story is a result of the cooperative efforts of state, federal, and local government; private citizens; business and industry; and the state's electric cooperatives.

Table 7.7. Missouri NOAA Weather Radio Stations

Site Name	Site Location	Call Sign	Frequency	Power
Alton	Alton	KXI35	162.5	300
Bellflower	Montgomery County	WNG728	162.45	1000
Bloomfield	Idalia	WXL47	162.4	1000
Bourbon	Crawford County	WWF75	162.525	1000
Branson	Reeds Spring	KZZ43	162.55	1000
Camdenton	Osage Beach	WXJ90	162.55	1000
Cameron	Cameron	KZZ85	162.475	300
Cape Girardeau	Cape Girardeau	KXI93	162.55	300
Carrollton	Carrollton	KZZ34	162.45	1000
Cassville	Cassville	WNG608	162.525	300
Clinton	Shawnee Mound	KZZ39	162.5	1000
Columbia	Fulton	WXL45	162.4	1000
Dixon	Fort Leonard Wood	WNG648	162.425	1000
Doniphan	Doniphan	WWG48	162.45	1000
El Dorado Springs	El Dorado Springs	KZZ30	162.475	1000
Fredricktown	Fredricktown	WWG49	162.5	1000
Gainesville	Gainesville	KZZ82	162.425	1000
Hannibal	Hannibal	WXK82	162.475	1000
Hermitage	Lake PomDeTerre	WXM81	162.45	100
Jamestown	Prairie Home	KWN55	162.425	1000
Joplin	Avilla Carthage	WXJ61	162.425	1000
Kahoka	Kahoka	WXL99	162.45	300
Kansas City	Independence	KID77	162.55	1000
La Plata	La Plata	WXM39	162.525	330
Lancaster	Lancaster	WXM36	162.55	300
Maryville	Maryville	KZZ37	162.425	1000
Piedmont	Sanders Hollow	KXI66	162.425	1000
Saint Joseph	Wathena	KEC77	162.4	1000
Springfield	Fordland	WXL46	162.4	1000
St. Louis	Shrewsbury	KDO89	162.55	1000
Summersville	Summersville	WWF76	162.475	1000
Trenton	Galt	KZZ38	162.5	1000
Wardell	Gideon Junction	WWG47	162.525	300
West Plains	West Plains	KXI38	162.525	300

Source: National Weather Service

Figure 7.3. Missouri's NOAA Weather Radio Coverage



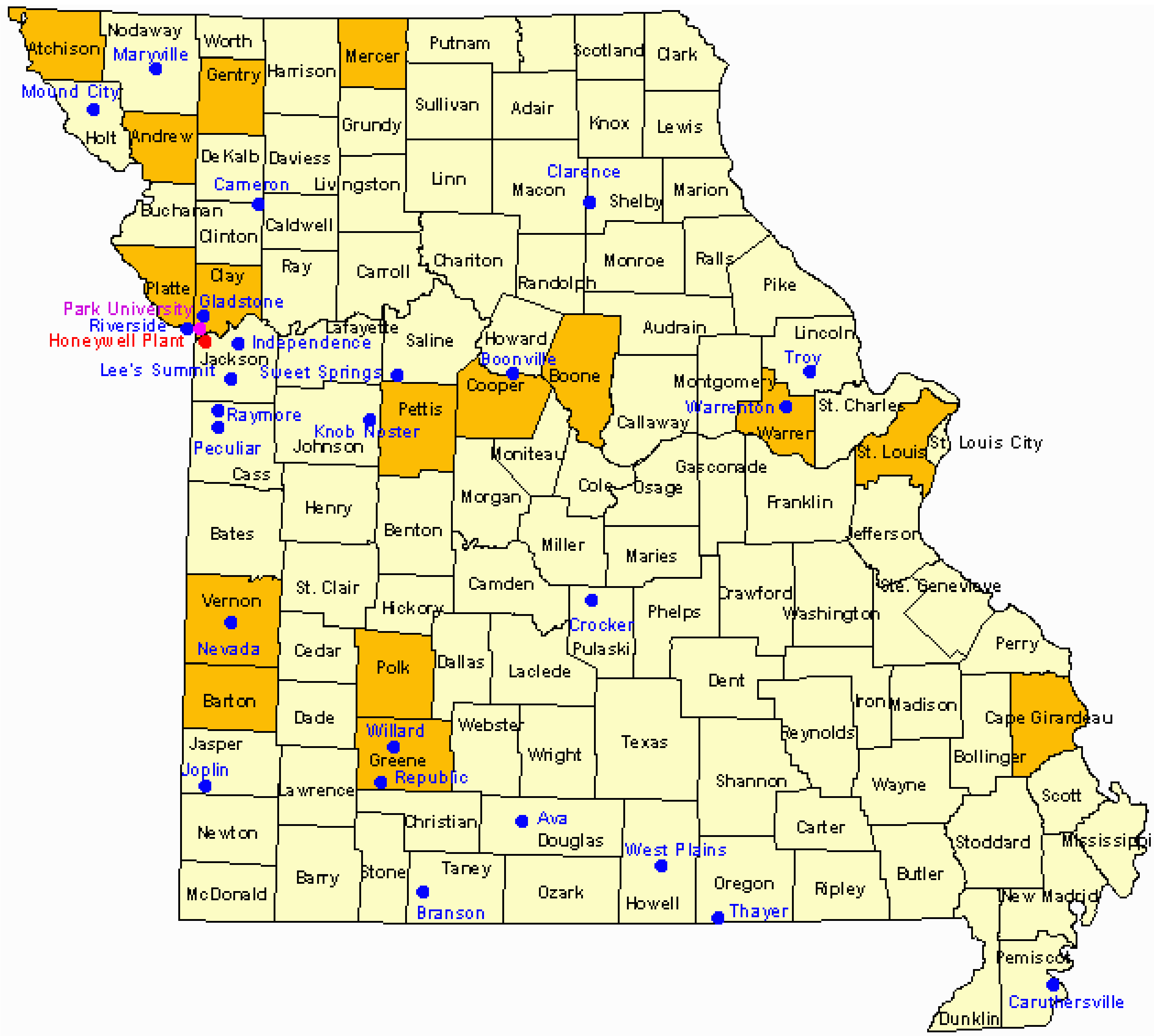
Source: National Weather Service
Notes:
White: Signal level of greater than 18dBuV: Reliable coverage
Green: 0dBuV to 18dBuV: picking up a signal is possible but unreliable
Pink: Less than 0dBuV: Unlikely to receive a signal

The expanded severe weather warning coverage provided by these transmitters benefits everyone in the state. By providing early warnings for severe weather, these transmitters enable people in the affected areas to take cover and protect themselves from severe weather.

National Oceanic and Atmospheric Administration (NOAA) StormReady Program

Since the 2004 plan, Missouri has made significant progress in preparing its communities for severe weather. With a total of 43 StormReady designations, Missouri more than doubled the number of counties participating in the voluntary program, increased the number of communities, and added a university. In 2004, there were 7 counties, 20 communities, and 1 commercial site, and in early 2007, there were 16 counties, 25 communities, 1 commercial site (there are only 5 nationwide), and 1 university. Missouri's current StormReady designations are illustrated in Figure 7.4.

Figure 7.4. Missouri's StormReady Designations



Source: National Weather Service

Notes:

Gold Shading: StormReady County Purple Dot: StormReady University

Blue Dot: StormReady Community Red Dot: StormReady Commercial Site

Disaster Resistant Community Program

Through the state's Disaster Resistant Community program, in conjunction with the former FEMA Project Impact program, the civic and political leaders of eight communities developed and instituted sound mitigation actions in their respective communities. While only eight communities are formally recognized as "Disaster Resistant Communities," as of early 2007, the majority of Missouri communities had local hazard mitigation plans and many were implementing hazard mitigation activities.

Other Mitigation Projects

The following success stories highlight the potential for future loss reduction and how mitigation projects have been successful in meeting multiple community objectives and effectively leveraging partnerships.

City of Neosho

This city has successfully developed a stormwater utility and has used the funds to create detention basins and improve the aesthetics of the downtown area. These efforts were spurred by participation in an earlier flood buyout program, where the success of mitigation was apparent to the residents and leaders of this community.

Kansas City

Kansas City used its own tax revenue to elevate a low bridge that had been overtopped by a flash flood in 1998 that killed eight people. The Prospect Bridge was elevated in conjunction with creek stabilization and open space improvements using "No Adverse Impact" principles of floodplain management. The very weekend the bridge was dedicated in October 2004, the area experienced heavy rains that could have resulted in flooding if the bridge had not been replaced.

City of Piedmont

This city has an annual creek cleanup, in cooperation with the Department of Conservation and the Natural Resource Conservation Service. This is an example of a true community cooperative effort that involves these agencies as well as local volunteers, including local boy scouts. The cleanup helps reduce flooding by reducing channel clogging debris. The aesthetics of the community are improved and the environmental benefits include improved habitat for fish.

Hannibal

The Mississippi River has always been a threat to Hannibal, and after eight close calls over three decades, local businessmen, banks, and city government raised the $850,000 local share for a $5.8 million flood wall. The wall, which was constructed between the town and the river, was completed barely one year before the 1993 flood. The U.S. Corps of Engineers estimated that the wall prevented $14.5 million in damage to downtown Hannibal, more than two times what it cost.

Other areas of Hannibal did not fare so well. Because of the large number of homes that were damaged, the state was quick to initiate a buyout program. The program proved to be successful when, in 1995, another flood struck Hannibal. This time though, no one was forced from their homes, and no homes were ruined. The people and their homes had been moved out of harm's way. In all, 116 homes were purchased in Hannibal through the buyout program, and the land, once a burden, is now an asset, serving a variety of recreational, even revenue generating, purposes.

Additional Projects

Listed below are more examples of the types of mitigation projects that have been undertaken by communities throughout the state. These projects were cost-effective based on the FEMA benefit-cost analysis module, and they provided a benefit to their communities by decreasing the impact of related disasters.

City of Richmond—Drop box installation ($2,434), to alleviate flooding caused by stormwater runoff, which exceeded capacity of old drainage system.

Moniteau County—Culvert replacement at four locations ($8,731), to replace and upgrade culverts at four locations.

Platte County—Culvert upgrade at two locations ($20,371), to upgrade culverts where capacity was not sufficient to handle run off from heavy rain events.

Platte County—Sewer upgrade ($11,927), to replace storm sewer in residential area, which was no longer collecting stormwater.

City of Blue Springs—Sewer upgrade ($177,455), to increase capacity of sanitary sewer system in residential area, which would overflow during heavy rain events.

City of Grain Valley—Culvert upgrade ($91,000), to increase capacity of stormwater culvert in residential area, which would overflow during heavy rain events.

City of Grain Valley—Manhole repairs ($32,979), to clean, repair, and seal 48 manholes to prevent infiltration of stormwater into the sanitary sewer system.

City of Lee's Summit—Sewer upgrade ($669,000), to increase capacity of sanitary sewer system in residential area, which would overflow during heavy rain events.

City of Greenwood—Sewer upgrade ($288,233), to replace existing storm sewer system in residential area, which had deteriorated to 10 percent of capacity.

City of Savannah—Sewer improvements ($336,837), to install improved drainage system in commercial and residential area, which overflowed during heavy rain events.

7.6 Commitment to a Comprehensive Mitigation Program

Requirement §201.5(b)(4)(i-vi):	The enhanced plan must demonstrate that the state is committed to a comprehensive state mitigation program, which might include any of the following: • A commitment to support local mitigation planning by providing workshops and training, state planning grants, or coordinated capability development of local officials, including emergency management and floodplain management certifications. • A statewide program of hazard mitigation through the development of legislative initiatives, mitigation councils, formation of public/private partnerships, and /or other executive actions that promote hazard mitigation. • The state provides a portion of the nonfederal match for HMGP and/or other mitigation projects. • To the extent allowed by state law, the state requires or encourages local governments to use a current version of a nationally applicable model building code or standard that addresses natural hazards as a basis for design and construction of state sponsored mitigation projects. • A comprehensive, multiyear plan to mitigate the risks posed to the existing buildings that have been identified as necessary for postdisaster response and recovery operations. • A comprehensive description of how the state integrates mitigation into its postdisaster recovery operations.

Throughout this plan SEMA and the state have documented their commitment to a comprehensive mitigation program. The effectiveness of this program was demonstrated in Section 7.5 Effective Use of Available Mitigation Funding and in Section 7.3 Program Management Capability.

Missouri has been in the forefront in mitigation nationally, demonstrated by being one of the first states to develop a FEMA approved ‘enhanced’ state mitigation plan in 2004. In 2004, the plan demonstrated a commitment to address the “data limitation” noted in the risk assessment and hazard analysis and the lack of approved local hazard mitigation plans through the establishment of mitigation action category M1—State and Local Hazard Mitigation Plans. In 2007, SEMA has documented how the state continues that commitment. As of February 2007, 94 of 115 Missouri counties (including St. Louis City), which altogether accounts for 94 percent of Missouri’s population, had hazard mitigation plans that met the requirements of both the Disaster Mitigation Act of 2000 and the Flood Mitigation Assistance Program.

Missouri's commitment to mitigation is integrated into each section of this plan, and represented in this plan as a whole. Some examples of the evidence of the state's commitment to mitigation can be referenced in:

- Section 2.1.1 Evolution of the State Hazard Mitigation Plan and Section 4.2 State Capability Assessment for organizations within the state that have consistently promoted mitigation:
  - Governor's Task Force on Flood Plain Management
  - Long-Term Recovery and Unmet Needs Groups
  - Structural Assessment and Visual Evaluation Coalition
  - Missouri Seismic Safety Commission
  - Regional Planning Commissions/Councils of Government
  - Hazard Mitigation Planning Team (formerly the Hazard Mitigation Project Coordinating Group)
- Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for a demonstration of additional commitment in vulnerability assessment. Missouri is one of the few states to have completed countywide HAZUS-MH flood and earthquake loss estimations for every county in the state.
- Chapter 4 Comprehensive State Hazard Mitigation Program for an outline of the mitigation objectives identified to raise the level of mitigation commitment:
  - Objective 1.3—Supports the development of sensible enabling legislation, programs, and capabilities of federal, state, and local governments and public-private partnerships engaged in mitigation activities
  - Objective 2.5—Encourages federal, state, and local officials; educational institutions; private associations; and private business entities that provide essential services to incorporate mitigation into other plans
  - Objective 3.2—Strengthens cooperation with SEMA's mitigation partners and helps educate them about mitigating the loss of property
  - Objective 4.2—Considers sustainability issues (ecologically sound, economically viable, socially just, and humane) when developing or reviewing mitigation projects and plans

SEMA's true commitment to a comprehensive state mitigation program may be best demonstrated through the agency's efforts to meet the Emergency Management Accreditation Program (EMAP) standards. The fact that SEMA has worked diligently to meet the EMAP standards and was conditionally accredited in 2007 (1 of only 15 states that are accredited or conditionally accredited) is testimony to the importance that SEMA places on mitigation (and emergency management, in general). Mitigation and state mitigation planning programs are critical elements of the EMAP standard for mitigation. Section 4.4 Mitigation Actions documents how the 11 EMAP mitigation criteria are met and interlaced throughout Missouri state agencies, not just SEMA.

Appendix A: Funding and Assistance Programs

Program/Activity	Type of Assistance	Agency and Contact
General Emergency Management Grants, Loans, and Technical Assistance		
Hazard Mitigation Grant Program	Postdisaster project grants to implement measures that will permanently reduce or eliminate future damages and losses from natural hazards through safer building practices and by improving existing structures and supporting infrastructure.	FEMA Region VII (816) 283-7969 www.fema.gov/government/grant/hmgp/index.shtm www.fema.gov/about/contact/regionvii.shtm SEMA (573) 526-9100 http://sema.dps.mo.gov/
Pre-Disaster Mitigation Program	Competitive project grants for cost-effective hazard mitigation activities that are part of a comprehensive mitigation program and that reduce injuries, loss of life, and damage and destruction of property.	FEMA Region VII (816) 283-7063 www.fema.gov/government/grant/pdm/index.shtm www.fema.gov/about/contact/regionvii.shtm SEMA (573) 526-9100 http://sema.dps.mo.gov/
Disaster Mitigation Planning and Technical Assistance	Technical and planning assistance for capacity building and mitigation project activities focusing on creating disaster resistant jobs and workplaces.	Economic Development Administration (800) 345-1222 (202) 482-6225 www.eda.gov/ SEMA (573) 526-9116 http://sema.dps.mo.gov/
Emergency Management/Mitigation Training	Training in disaster mitigation, preparedness, and planning.	FEMA Region VII NFIP and Mitigation (816) 283-7002 http://training.fema.gov/

Program/Activity	Type of Assistance	Agency and Contact
Emergency Management/Mitigation Training (continued)		SEMA (573) 526-9116 http://sema.dps.mo.gov/trn.htm
Postdisaster Economic Recovery Grants and Assistance	Grant funding to assist with the long-term economic recovery of communities, industries, and firms adversely impacted by disasters.	Economic Development Administration (800) 345-1222 (202) 482-6225 www.eda.gov/ Missouri Department of Economic Development Community Development Block Grant Program (573) 751-4146 http://ded.mo.gov/
Physical Disaster Loans and Economic Injury Disaster Loans	Disaster loans to nonfarm, private sector owners of disaster damaged property for uninsured losses. Loans can be increased by up to 20 percent for mitigation purposes.	Small Business Administration (202) 205-6734 www.sba.gov/services/disasterassistance
Disaster Grants—Public Assistance	Grants for the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain private nonprofit organizations. Mitigation funding is available for work related to damaged components of eligible buildings/structures.	FEMA Region VII (816) 283-7025 www.fema.gov/government/grant/pa/index.shtm SEMA (573) 526-9112 http://sema.dps.mo.gov/
Public Infrastructure Grants	• Public Facilities: Grants for public improvement of facilities except work on general public office buildings, includes water facilities, flood and drainage facilities, fire protection facilities/equipment, and bridges. • Neighborhoods: Grants for housing and some public facilities. • Infrastructure: Grants for storm sewers, drainage, and land acquisitions. • Downtown Revitalization: Grants for improving	Missouri Department of Economic Development Community Development Block Grant Program (573) 751-4146 (573) 751-3600 http://ded.mo.gov/

Program/Activity	Type of Assistance	Agency and Contact
Public Infrastructure Grants (continued)	public infrastructure and facilities in a central business district. • Emergencies: Grants for public improvement or facilities except work on general public office buildings, includes water facilities and solid waste disposal facilities.	
Community Development Block Grants State's Program	Grants to states to develop viable communities (e.g., housing, a suitable living environment, expanded economic opportunities) in non-entitled areas, for low- and moderate-income persons.	U.S. Department of Housing and Urban Development Community Planning and Development (202) 708-3587 x4538 www.hud.gov/offices/cpd/index.cfm HUD Kansas City Regional Office (western half of MO) (913) 551-5644 www.hud.gov/local/mo/community/slideshowkansascity.cfm HUD St. Louis Field Office (eastern half of MO) (314) 539-6583 www.hud.gov/local/mo/community/slideshowstlouis.cfm Missouri Department of Economic Development (573) 751-4146 http://ded.mo.gov/
Community Development Block Grants/Entitlement Grants	Grants to entitled cities and urban counties to develop viable communities (e.g., decent housing, suitable living environments, expanded economic opportunities), principally for low- and moderate-income persons.	U.S. Department of Housing and Urban Development (HUD) Community Planning and Development (202) 708-3587 x4538 www.hud.gov/offices/cpd/index.cfm HUD Kansas City Regional Office (western half of MO) (913) 551-5644 www.hud.gov/local/mo/community/slideshowkansascity.cfm

Program/Activity	Type of Assistance	Agency and Contact
Community Development Block Grants/Entitlement Grants (continued)		HUD St. Louis Field Office (eastern half of MO) (314) 539-6583 www.hud.gov/local/mo/community/slideshowstlouis.cfm Missouri Department of Economic Development CDBG Program (573) 751-4146 http://ded.mo.gov/
Disaster Recovery Assistance	Critical housing and community development resources to aid disaster recovery (including mitigation).	U.S. Department of Housing and Urban Development (HUD) Community Planning and Development (202) 708-2605 www.hud.gov/offices/cpd/index.cfm HUD Kansas City Regional Office (western half of MO) (913) 551-5644 www.hud.gov/local/mo/community/slideshowkansascity.cfm HUD St. Louis Field Office (eastern half of MO) (314) 539-6583 www.hud.gov/local/mo/community/slideshowstlouis.cfm Missouri Department of Economic Development Missouri Housing Development Commission (816) 759-6600 www.mhdc.com/

Program/Activity	Type of Assistance	Agency and Contact
Public Housing Capital Fund Emergency/Natural Disaster Funding	Funding to public housing agencies that confront an emergency situation or a natural disaster.	U.S. Department of Housing and Urban Development Office of Capital Improvements (202) 708-0950 www.hud.gov/offices/pih/programs/ph/capfund/index.cfm Missouri Department of Economic Development Missouri Housing Development Commission (816) 759-6600 www.mhdc.com/
Indian Housing Assistance (Housing Improvement Program)	Project grants and technical assistance to eliminate substantially sub-standard Indian owned and inhabited housing.	Bureau of Indian Affairs Division of Housing Assistance Office of Tribal Services (202) 513-7640 www.doi.gov/bureau-indian-affairs.html
Single Family Housing Repair Loans and Grants (Section 504 Rural Housing Loans and Grants)	Repair loans, grants, and technical assistance for very low-income homeowners living in rural areas to repair their homes and remove health and safety hazards.	U.S. Department of Agriculture (USDA) Rural Development Housing and Community Facilities Programs (202) 720-1474 www.rurdev.usda.gov/rhs/ USDA Rural Development State Office—Missouri (573) 876-0976 www.rurdev.usda.gov/mo/
Guaranteed Single Family Housing Loans (Section 502 Rural Housing Loans)	Loans, loan guarantees, and technical assistance to help very low, low-income, and moderate-income households in rural areas buy, build, or improve permanent residences.	U.S. Department of Agriculture (USDA) Rural Development Housing and Community Facilities Programs (202) 720-1474 (direct loans) (202) 720-1452 (guaranteed loans) www.rurdev.usda.gov/rhs/ USDA Rural Development State Office—Missouri (573) 876-0976 www.rurdev.usda.gov/mo/

Program/Activity	Type of Assistance	Agency and Contact
Farm Ownership Loans	Direct loans, guaranteed/insured loans, and technical assistance to farmers to develop, construct, improve, or repair farm homes, farms, and service buildings and to make other necessary improvements.	U.S. Department of Agriculture Farm Service Agency (202) 720-1632 www.fsa.usda.gov/ Missouri Department of Agriculture (573) 751-4211 http://mda.mo.gov/
HOME Investment Partnerships Program	Grants to states, local government, and consortia for permanent and transitional housing (including support for property acquisition, improvements, demolition, and relocation) for very low and low-income persons.	U.S. Department of Housing and Urban Development (HUD) Community Planning and Development Affordable Housing Programs HOME Investment Partnership Programs (202) 708-2470 www.hud.gov/offices/cpd/affordablehousing/index.cfm Missouri Department of Economic Development Missouri Housing Development Commission (816) 759-6600 www.mhdc.com/
Rural Development Assistance—Housing	Grants, loans, and technical assistance for addressing rehabilitation and health and safety needs in primarily low-income rural areas. Declaration of major disaster necessary.	U.S. Department of Agriculture (USDA) Rural Development Housing and Community Facilities Programs (202) 720-4323 www.rurdev.usda.gov/rhs/ USDA Rural Development State Office—Missouri (573) 876-0976 www.rurdev.usda.gov/mo/
Rural Development Assistance—Utilities	Direct and guaranteed rural economic loans and business enterprise grants to address utility issues and development needs.	U.S. Department of Agriculture (USDA) Rural Development Utilities Program (202) 720-9540 www.rurdev.usda.gov/rhs/

Program/Activity	Type of Assistance	Agency and Contact
Rural Development Assistance—Utilities (continued)		USDA Rural Development State Office—Missouri (573) 876-0976 www.rurdev.usda.gov/mo/
Rural Development Assistance—Community Facility Direct Loans/Grants	Grants, direct and guaranteed loans, and technical assistance to construct, enlarge, or improve community facilities for healthcare, public safety, and public services in primarily low-income rural areas.	U.S. Department of Agriculture (USDA) Rural Development Housing and Community Facilities Programs (202) 720-4323 www.rurdev.usda.gov/rhs/cf/cp.htm USDA Rural Development State Office—Missouri (573) 876-0976 www.rurdev.usda.gov/mo/
Rural Community Fire Protection	Grants for rural fire projects or assistance, including dry fire hydrants, equipment, and training.	Missouri Department of Conservation (573) 751-4115, x-3111 (573) 346-2210 www.mdc.mo.gov/forest/fire/programs.htm#rfcpp
Community Development Block Grant—Section 108 Loan Guarantees	Loan guarantees to public entities for economic development, housing rehabilitation, public facilities, and large-scale physical development projects (including mitigation measures).	U.S. Department of Housing and Urban Development Community Planning and Development/Section 108 (202) 708-1871 www.hud.gov/offices/cpd/communitydevelopment/programs/ HUD Kansas City Regional Office (western half of MO) (913) 551-5644 www.hud.gov/local/mo/community/slideshowkansascity.cfm HUD St. Louis Field Office (eastern half of MO) (314) 539-6583 www.hud.gov/local/mo/community/slideshowstlouis.cfm Missouri Department of Economic Development Missouri Housing Development Commission (816) 759-6600 www.mhdc.com/

Program/Activity	Type of Assistance	Agency and Contact
Homeland Security Grant Program	Grants to enhance the ability of states, territories, and urban areas to prepare for, prevent, and respond to terrorist attacks and other major disasters. Includes State Homeland Security Program, Urban Areas Security Initiative, Law Enforcement Terrorism Prevention Program, Metropolitan Medical Response System, and Citizen Corps Program grant programs.	FEMA Grants Management (800) 368-6498 askcsid@dhs.gov www.ojp.usdoj.gov/odp/grants_hsgp.htm
Infrastructure Protection Program	Grants to strengthen the nation's ability to protect critical infrastructure facilities and systems. Includes Transit Security Grant Program, Port Security Grant Program, Intercity Bus Security Grant Program, Trucking Security Program, and Buffer Zone Protection Program grant programs.	FEMA Grants Management (800) 368-6498 askcsid@dhs.gov www.ojp.usdoj.gov/odp/grants_ipp2007.htm
Assistance to Firefighters Grant Program	Grants to local fire departments to protect citizens and firefighters against the effects of fire and fire-related incidents.	FEMA Grants Management (866) 274-0960 firegrants@dhs.gov www.firegrantsupport.com/afg/ FEMA Region VII (816) 283-7951
Fire Prevention and Safety Grant Program	Grants for projects that enhance the safety of the public and firefighters from fire and related hazards. The primary goal is to target high-risk populations and mitigate high incidences of death and injury.	FEMA Grants Management (866) 274-0960 firegrants@dhs.gov www.firegrantsupport.com/afg/ FEMA Region VII (816) 283-7951 www.fema.gov/about/contact/regionvii.shtm
Fire Management Assistance Grant Program	Grants for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands, which threaten such destruction as would constitute a major disaster.	FEMA Region VII (816) 283-7025 www.fema.gov/government/grant/fmagp/index.shtm

Program/Activity	Type of Assistance	Agency and Contact
Hazardous Materials Emergency Preparedness Program	Project grants and technical assistance to enhance hazardous materials emergency planning and training.	U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration Office of Hazardous Materials Safety (202) 366-0001 http://hazmat.dot.gov/training/state/hmep/hmep.htm
Floods/Flood Control Grants, Loans, and Technical Assistance		
Flood Mitigation Assistance Program	Planning, project, and technical assistance grants to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program.	FEMA Region VII (816) 283-7063 www.fema.gov/government/grant/fma/index.shtm www.fema.gov/about/contact/regionvii.shtm SEMA (573) 526-9100 http://sema.dps.mo.gov/
Repetitive Flood Claims Program	Project grants for activities that reduce or eliminate the long-term risk of flood damage to structures insured under the National Flood Insurance Program that have had one or more claims for flood damages.	FEMA Region VII (816) 283-7063 www.fema.gov/government/grant/rfc/index.shtm www.fema.gov/about/contact/regionvii.shtm SEMA (573) 526-9100 http://sema.dps.mo.gov/
Severe Repetitive Loss Program	Project grants to reduce or eliminate claims under the National Flood Insurance Program through activities that will result in the greatest savings to the National Flood Insurance Fund.	FEMA Region VII (816) 283-7063 www.fema.gov/government/grant/srl/index.shtm www.fema.gov/about/contact/regionvii.shtm SEMA (573) 526-9100 http://sema.dps.mo.gov/

Program/Activity	Type of Assistance	Agency and Contact
National Flood Insurance Program	Flood insurance to residents of communities that adopt and enforce minimum floodplain management requirements.	FEMA Region VII NFIP and Mitigation (816) 283-7002 www.fema.gov/about/programs/nfip/index.shtm www.floodsmart.gov/floodsmart/pages/index.jsp SEMA (573) 526-9141 http://sema.dps.mo.gov/NFIP%20Page.htm
Flood Control Planning Assistance	Technical and planning assistance for the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources.	U.S. Army Corps of Engineers (USACE) www.usace.army.mil/ Omaha District (northwest MO) (402) 221-3917 www.nwo.usace.army.mil/ Rock Island District (northeast MO) (309) 794-4200 www.mvr.usace.army.mil/ Kansas City District (west central MO) (816) 389-2000 www.nwk.usace.army.mil/ St. Louis District (east central MO) (314) 331-8644 www.mvs.usace.army.mil/ Little Rock District (southern MO) (501) 324-5551 www.swl.usace.army.mil/ Memphis District (southeast MO) (901) 544-3005 www.mvm.usace.army.mil/

Program/Activity	Type of Assistance	Agency and Contact
Flood Control Planning Assistance (continued)		Tulsa District (southwest MO) (918) 669-7366 www.swt.usace.army.mil/
Nonstructural Alternatives to Structural Rehabilitation of Damaged Flood Control Works	Direct planning and construction grants for nonstructural alternatives to the structural rehabilitation of flood control works damaged in floods or coastal storms.	U.S. Army Corps of Engineers (USACE) www.usace.army.mil/ Omaha District (northwest MO) (402) 221-3917 www.nwo.usace.army.mil/ Rock Island District (northeast MO) (309) 794-4200 www.mvr.usace.army.mil/ Kansas City District (west central MO) (816) 389-2000 www.nwk.usace.army.mil/ St. Louis District (east central MO) (314) 331-8644 www.mvs.usace.army.mil/ Little Rock District (southern MO) (501) 324-5551 www.swl.usace.army.mil/ Memphis District (southeast MO) (901) 544-3005 www.mvm.usace.army.mil/ Tulsa District (southwest MO) (918) 669-7366 www.swt.usace.army.mil/

Program/Activity	Type of Assistance	Agency and Contact
Floodplain Management Services	Technical and planning assistance at the local, regional, or national level needed to support effective floodplain management.	U.S. Army Corps of Engineers (USACE) www.usace.army.mil/ Omaha District (northwest MO) (402) 221-3917 www.nwo.usace.army.mil/ Rock Island District (northeast MO) (309) 794-4200 www.mvr.usace.army.mil/ Kansas City District (west central MO) (816) 389-2000 www.nwk.usace.army.mil/ St. Louis District (east central MO) (314) 331-8644 www.mvs.usace.army.mil/ Little Rock District (southern MO) (501) 324-5551 www.swl.usace.army.mil/ Memphis District (southeast MO) (901) 544-3005 www.mvm.usace.army.mil/ Tulsa District (southwest MO) (918) 669-7366 www.swt.usace.army.mil/
Land Protection	Technical assistance for run-off retardation and soil erosion prevention to reduce hazards to life and property.	U.S. Department of Agriculture Natural Resources Conservation Service (202) 720-4527 www.usda.gov/

Program/Activity	Type of Assistance	Agency and Contact
Stormwater Grant Program	Grants for planning and construction of stormwater facilities. Only 1st class counties, cities in 1st class counties, and St. Louis City are eligible. Funds based on population base. County offices can approve/deny a city application (if population less than 25,000).	Missouri Department of Natural Resources Water Protection Program Water Pollution Control Branch Stormwater Grant Program (573) 751-1300 cleanwater@dnr.mo.gov www.dnr.mo.gov/env/wpp/wp-index.html
Dam Safety Programs	Technical assistance, training, and grants to help improve state dam safety programs.	FEMA Region VII NFIP and Mitigation (816) 283-7002 www.fema.gov/plan/prevent/damfailure/ndsp.shtm Missouri Department of Natural Resources Water Resources Center Dam and Reservoir Safety Program (573) 368-2177, (800) 334-6946, TDD (800) 379-2419 dams@mail.dnr.state.mo.us www.dnr.mo.gov/env/wrc/damsft/damsfthp.htm
Earthquake Grants, Loans, and Technical Assistance		
National Earthquake Hazards Reduction Program and Other Earthquake Hazards Reduction Programs	Technical and planning assistance for activities associated with earthquake hazards mitigation.	FEMA Region VII NFIP and Mitigation (816) 283-7002 www.nehrp.gov/ SEMA (573) 526-9131 http://sema.dps.mo.gov/EQ.htm
Geological Survey Program	Acquire, maintain, and manage basic geological data and identify and evaluate geological hazards. The Geological Survey Program assists Missourians, industry, and government in the wise use of Missouri's minerals, land, and water resources.	Missouri Department of Natural Resources Division of Geology and Land Survey Geological Survey Program (573) 368-2300, TDD (800) 379-2419 gspgeol@dnr.mo.gov www.dnr.mo.gov/geology/geosrv/

Program/Activity	Type of Assistance	Agency and Contact
All-Hazard Mapping Grants, Loans, and Technical Assistance		
National Flood Insurance Program: Flood Mapping	Flood insurance rate maps and floodplain management maps for all NFIP communities.	FEMA Region VII NFIP and Mitigation (816) 283-7002 www.fema.gov/business/nfip/mscjumppage.shtm SEMA (573) 526-9141
National Digital Orthophoto Programs	Develops topographic quadrangles for use in mapping of flood and other hazards.	U.S. Geological Survey National Mapping Division (573) 308-3802 ortho@ndop.gov www.ndop.gov/ SEMA (573) 526-9141
National Streamflow Information Program	Operation of a network of over 7,000 stream gaging stations that provide data on river flood characteristics.	U.S. Geological Survey Office of Surface Water (703) 648-5303 http://water.usgs.gov/nsip/
Mapping Standards Support	Expertise in mapping and digital data standards to support the National Flood Insurance Program.	U.S. Geological Survey National Mapping Division (573) 308-3802 www.ndop.gov/ SEMA (573) 526-9141
Earthquake Hazards Program	Seismic hazard maps.	U.S. Geological Survey (703) 648-6785 http://earthquake.usgs.gov/ Missouri Department of Natural Resources Division of Geology and Land Survey Geological Survey Program

Program/Activity	Type of Assistance	Agency and Contact
Earthquake Hazards Program (continued)		(573) 368-2815 geopubs@dnr.mo.gov www.dnr.mo.gov/geology/geosrv/geores/EQmaps.htm SEMA (573) 526-9212 http://sema.dps.mo.gov/EQ.htm
Cooperating Technical Partners	Technical assistance, training, and data to support flood hazard data development activities.	FEMA Region VII (816) 283-7073 www.fema.gov/plan/prevent/fhm/ctp_main.shtm
Map Modernization Management Support	Provides funding to supplement, not supplant, ongoing flood hazard mapping management efforts by local, regional, and State agencies.	FEMA Region VII NFIP and Mitigation (816) 283-7002 www.fema.gov/plan/prevent/fhm/mm_main.shtm
Community Assistance Program State Support Services Element (CAP-SSSE)	Provides funding to states to provide technical assistance to communities in the National Flood Insurance Program (NFIP) and to evaluate community performance in implementing NFIP floodplain management activities.	FEMA Region VII NFIP and Mitigation (816) 283-7002 SEMA (573) 526-9141
Geospatial One-Stop (geodata.gov)	GIS portal that contains metadata records and links to live maps, features, and catalog services, downloadable data sets, images, clearinghouses, map files, and more.	Geospatial One-Stop geodata@usgs.gov http://gos2.geodata.gov/
Missouri Spatial Data Information Service	Provides GIS and census data about the State of Missouri.	Missouri Spatial Data Information Service University of Missouri–Columbia (573) 882-1404 msdismail@missouri.edu http://msdisweb.missouri.edu/
Center for Agriculture, Resource, and Environmental Systems	Provides maps and research findings to help better address resource, environmental, and socioeconomic issues.	Center for Agriculture, Resource, and Environmental Systems University of Missouri–Columbia (573) 882-7458 www.cares.missouri.edu/

Program/Activity	Type of Assistance	Agency and Contact
Ancillary Flood and Natural Resource Projects Grants, Loans, and Assistance		
Natural Resources Financial Assistance	Financial and technical assistance programs available to Missouri communities.	Missouri Department of Natural Resources (573) 751-3443, (800) 334-6946, TDD (800) 379-2419 contact@dnr.mo.gov
	• User Charge Analysis—Computer software assisted analysis of water and wastewater user charge systems.	Water Pollution Control Branch Water Protection Program (573) 751-1300 www.dnr.mo.gov/env/wpp/wp-index.html
	• Agriculture Loan Program—Loans to individual farmers for animal waste treatment facilities.	Missouri Department of Agriculture (573) 751-2129
	• Cooperative Remonumentation Program—Contract with county commissions to remonument corners of the U.S. Public Land Survey System. • County Boundary Resurvey Program—Contract with county commissions to remonument county boundary lines where location of line is indefinite. • Geodetic Control Densification Project—Contract with county, city government, and municipal utilities to establish horizontal and vertical control monuments used for mapping and the development of land survey information system.	State Surveyor (573) 368-2301
	• Hazardous Substance Emergency Relief Loan Fund—Loans to political subdivisions or volunteer fire protection associations for reimbursement of actual costs incurred in responding to a hazardous substance emergency.	Missouri Department of Natural Resources Environmental Services Program (573) 526-3315 envirolab@dnr.mo.gov www.dnr.mo.gov/env/esp/index.html
	• Local Government Reimbursement Program—Local communities can be reimbursed up to $25,000 for costs incurred in responding to a hazardous substance emergency.	U.S. Environmental Protection Agency Local Governments Reimbursement (800) 431-9209 www.epa.gov/superfund/programs/er/lgr/

Program/Activity	Type of Assistance	Agency and Contact
Natural Resources Financial Assistance (continued)	• Leaking Underground Storage Tank Cleanup Assistance—At eligible sites with preapproved plans and costs, the Underground Storage Tank Fund can assist the responsible party with the cleanup costs. • Private Activity Bond Financing—Issuance of tax-exempt and taxable revenue bonds for private and public companies for facilities and improvements with environmental and energy resource impacts.	Missouri Department of Natural Resources Hazardous Waste Management Program Tanks Section (573) 751-6822 hazwaste@dnr.mo.gov www.dnr.mo.gov/env/hwp/index.html Missouri Department of Natural Resources Environmental Improvement and Energy Resources Authority (573) 751-4919 eiera@dnr.mo.gov www.dnr.mo.gov/eiera/index.html
Environmental Quality Incentives Program	Technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands.	U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) (202) 720-1845 www.nrcs.usda.gov/programs/eqip/ NRCS District Office—Columbia, MO (573) 876-0912 Missouri Department of Natural Resources Soil and Water Conservation Program (573) 751-4932 soils@dnr.mo.gov www.dnr.mo.gov/env/swcp/index.html
Nonpoint Source Implementation Grants (Clean Water Act Section 319 Grants)	Grants to states to implement nonpoint source programs, including support for nonstructural watershed resource restoration activities.	U.S. Environmental Protection Agency Office of Water Non-Point Source Control Branch (202) 566-1203 www.epa.gov/owow/nps/cwact.html Missouri Department of Natural Resources Division of Environmental Quality Water Protection Program

Program/Activity	Type of Assistance	Agency and Contact
Nonpoint Source Implementation Grants (Clean Water Act Section 319 Grants) (continued)		Public Drinking Water Branch (573) 751-5331 drinkingwater@dnr.mo.gov www.dnr.mo.gov/env/wpp/dw-index.htm
Capitalization Grants for Clean Water State Revolving Funds	Loans to fund water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management.	U.S. Environmental Protection Agency Office of Wastewater Management The Clean Water State Revolving Fund Branch (202) 564-0752 www.epa.gov/owm/cwfinance/index.htm
National Wetland Program Development Grants	Grants to build capacity to protect, manage, and restore wetlands.	U.S. Environmental Protection Agency Office of Wetlands, Oceans, and Watersheds Wetlands Division (202) 566-1225 www.epa.gov/owow/wetlands/ Missouri Department of Natural Resources Water Resources Center (573) 751-2867, (573) 368-2175 mowaters@dnr.mo.gov www.dnr.mo.gov/env/wrc/index.html
Watershed Protection and Flood Prevention Program	Technical assistance for designing and installing watershed works of improvement and financial assistance for cost-sharing of measures for watershed protection, flood prevention, agricultural water management, sedimentation control, etc., in small watersheds under 250,000 acres.	U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Watersheds and Wetlands Division (202) 720-3534 www.nrcs.usda.gov/programs/watershed/ NRCS District Office—Columbia, MO (573) 876-0912 Missouri Department of Natural Resources Soil and Water Conservation Program (573) 751-4932 soils@dnr.mo.gov www.dnr.mo.gov/env/swcp/index.html

Program/Activity	Type of Assistance	Agency and Contact
Soil and Water Conservation Program	Technical assistance to the general public in planning and applying natural resource conservation practices, systems, and treatment; and furnishing technical natural resource conservation information to State and local governments.	U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) (202) 720-4527 www.nrcs.usda.gov/programs/swca/ NRCS District Office—Columbia, MO (573) 876-0912 Missouri Department of Natural Resources Soil and Water Conservation Program (573) 751-4932 soils@dnr.mo.gov www.dnr.mo.gov/env/swcp/index.html
Watershed Surveys and Planning	Technical assistance planning activities to help solve water and related land resources problems.	U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Watersheds and Wetlands Division (202) 720-3534 www.nrcs.usda.gov/programs/watershed/ NRCS District Office—Columbia, MO (573) 876-0912
Emergency Watershed Protection Program	Provides technical and financial assistance for relief from imminent hazards in small watersheds and to reduce vulnerability of life and property in small watershed areas damaged by natural hazard events.	U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Watersheds and Wetlands Division (202) 690-0793 www.nrcs.usda.gov/programs/ewp/ NRCS District Office—Columbia, MO (573) 876-0912
Wetlands Reserve Program	Financial and technical assistance to protect and restore wetlands through easements and restoration agreements.	U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Watersheds and Wetlands Division (202) 690-08487 www.nrcs.usda.gov/programs/wrp/

Program/Activity	Type of Assistance	Agency and Contact
Wetlands Reserve Program (continued)		NRCS District Office—Columbia, MO (573) 876-0912
Project Modifications for Improvement of the Environment	Provides for ecosystem restoration by modifying structures and/or operations or water resources projects constructed by the U.S. Army Corps of Engineers or restoring areas where a Corps project contributed to the degradation of an area.	U.S. Army Corps of Engineers (USACE) www.usace.army.mil/ Omaha District (northwest MO) (402) 221-3917 www.nwo.usace.army.mil/ Rock Island District (northeast MO) (309) 794-4200 www.mvr.usace.army.mil/ Kansas City District (west central MO) (816) 389-2000 www.nwk.usace.army.mil/ St. Louis District (east central MO) (314) 331-8644 www.mvs.usace.army.mil/ Little Rock District (southern MO) (501) 324-5551 www.swl.usace.army.mil/ Memphis District (southeast MO) (901) 544-3005 www.mvm.usace.army.mil/ Tulsa District (southwest MO) (918) 669-7366 www.swt.usace.army.mil/
Aquatic Ecosystem Restoration	Direct support for carrying out aquatic ecosystem restoration projects that will improve the quality of the environment.	U.S. Army Corps of Engineers (USACE) www.usace.army.mil/

Program/Activity	Type of Assistance	Agency and Contact
Aquatic Ecosystem Restoration (continued)		Omaha District (northwest MO) (402) 221-3917 www.nwo.usace.army.mil/ Rock Island District (northeast MO) (309) 794-4200 www.mvr.usace.army.mil/ Kansas City District (west central MO) (816) 389-2000 www.nwk.usace.army.mil/ St. Louis District (east central MO) (314) 331-8644 www.mvs.usace.army.mil/ Little Rock District (southern MO) (501) 324-5551 www.swl.usace.army.mil/ Memphis District (southeast MO) (901) 544-3005 www.mvm.usace.army.mil/ Tulsa District (southwest MO) (918) 669-7366 www.swt.usace.army.mil/
Planning Assistance to States (Water Resources Development Act)	Financial and technical assistance to prepare comprehensive plans for the development, use, and conservation of water and related land resources.	U.S. Army Corps of Engineers (USACE) (202) 272-0169 www.usace.army.mil/cw/cecw-cp/ Omaha District (northwest MO) (402) 221-3917 www.nwo.usace.army.mil/

Program/Activity	Type of Assistance	Agency and Contact
Planning Assistance to States (Water Resources Development Act) (continued)		Rock Island District (northeast MO) (309) 794-4200 www.mvr.usace.army.mil/ Kansas City District (west central MO) (816) 389-2000 www.nwk.usace.army.mil/ St. Louis District (east central MO) (314) 331-8644 www.mvs.usace.army.mil/ Little Rock District (southern MO) (501) 324-5551 www.swl.usace.army.mil/ Memphis District (southeast MO) (901) 544-3005 www.mvm.usace.army.mil/ Tulsa District (southwest MO) (918) 669-7366 www.swt.usace.army.mil/
Beneficial Uses of Dredged Materials	Direct assistance for projects that protect, restore, and create aquatic and ecologically-related habitats, including wetlands, in connection with dredging an authorized federal navigation project.	U.S. Army Corps of Engineers (USACE) www.usace.army.mil/ Omaha District (northwest MO) (402) 221-3917 www.nwo.usace.army.mil/ Rock Island District (northeast MO) (309) 794-4200 www.mvr.usace.army.mil/ Kansas City District (west central MO)

Program/Activity	Type of Assistance	Agency and Contact
Beneficial Uses of Dredged Materials (continued)		(816) 389-2000 www.nwk.usace.army.mil/ St. Louis District (east central MO) (314) 331-8644 www.mvs.usace.army.mil/ Little Rock District (southern MO) (501) 324-5551 www.swl.usace.army.mil/ Memphis District (southeast MO) (901) 544-3005 www.mvm.usace.army.mil/ Tulsa District (southwest MO) (918) 669-7366 www.swt.usace.army.mil/
North American Wetland Conservation Fund	Matching grants for projects that provide long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats in the United States.	U.S. Fish and Wildlife Service Division of Bird Habitat Conservation (703) 358-1784 dbhc@fws.gov www.fws.gov/birdhabitat/Grants/NAWCA/index.shtm
Soil Survey	Maintains soil surveys of counties or other areas to assist with farming, conservation, mitigation or related purposes.	U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Soil Science and Resource Assessment (202) 690- 4616 http://soils.usda.gov/survey/ NRCS District Office—Columbia, MO (573) 876-0912

Program/Activity	Type of Assistance	Agency and Contact
Land Acquisition	Acquires or purchases easements on high-quality lands and waters for inclusion into the National Wildlife Refuge System.	U.S. Fish and Wildlife Service Division of Realty (703) 358-1713 realty@fws.gov www.fws.gov/realty/lap.html
Transfers of Inventory Farm Properties to Federal and State Agencies for Conservation Purposes	Transfers title of certain inventory farm properties owned by the Farm Service Agency to federal and state agencies for conservation purposes (including the restoration of wetlands and floodplain areas to reduce future flood potential).	U.S. Department of Agriculture Farm Service Agency Farm Loan Programs (202) 720-3467, 1632
Disposal of Federal Surplus Real Property for Parks, Recreation, and Historic Monuments	Identifies, assesses, and transfers available federal real property for acquisition for state and local parks and recreation, such as open space.	National Park Service (NPS) (202) 354-6915 nps_flpnational@nps.gov www.ncrc.nps.gov/programs/flp/ NPS—Northeast/Midwest Regions (617) 223-5190 nps_flpnorth@nps.gov
Recreation and Parks Grants	Grants available to cities, counties, and school districts for outdoor recreation facilities and land acquisition.	Missouri Department of Natural Resources Division of State Parks (800) 334-6946 moparks@dnr.mo.gov www.mostateparks.com
Partners for Fish and Wildlife	Financial and technical assistance to private landowners interested in restoring or otherwise improving native habitats for fish and wildlife on their lands.	U.S. Fish and Wildlife Service Branch of Habitat Restoration (703) 358-2201 www.fws.gov/partners/
Tree Planting Program	Grants for planting trees for improving Missouri's erosion control, conservation, stream bank stabilization, etc.	Missouri Department of Conservation (573) 751-4115, x-3111 and x-3116 www.mdc.mo.gov/forest/
Conservation Contracts	Debt reduction for delinquent and nondelinquent borrowers in exchange for conservation contracts placed on environmentally sensitive real property that secures Farm Service Agency loans.	U.S. Department of Agriculture Farm Service Agency (202) 720-3467, 1632

Program/Activity	Type of Assistance	Agency and Contact
Historic Preservation Fund Grants	Federal matching grants, known as the Historic Preservation Fund to assist in carrying out historic preservation activities. Sponsored by the National Park Service.	Missouri Department of Natural Resources Division of State Parks Historic Preservation Program (800) 334-6946 moparks@dnr.mo.gov www.mostateparks.com
The Foundation Directory	Annual source of information about grants and loans from federal and private sources. Available for a fee.	The Foundation Directory (800) 478-4661 fdonline@fdncenter.org www.fconline.fdncenter.org/
Federal Assistance Monitor	Published by CD Publications. Semi-monthly report on federal and private grants. Available for a fee.	CD Publications (301) 588-6380, (800) 666-6380 info@cdpublications.com www.cdpublications.com/
Catalog of Federal Domestic Assistance	Database of all federal programs available to State and local governments; federally recognized Indian tribal governments; domestic public, quasi-public, and private profit and nonprofit organizations and institutions; specialized groups; and individuals.	Catalog of Federal Domestic Assistance http://12.46.245.173/cfda/cfda.html
Basic and Applied Research/Development		
Decision, Risk, and Management Sciences	Funding for research directed at increasing the understanding and effectiveness of decision making by individuals, groups, organizations, and society.	National Science Foundation Directorate for Social, Behavioral, and Economic Sciences (703) 292-8700 www.nsf.gov/dir/index.jsp?org=SBE
Science and Society	Funding for research that examines questions that arise in the interactions of engineering, science, technology, and society.	National Science Foundation Directorate for Social, Behavioral, and Economic Sciences 703) 292-8700 www.nsf.gov/dir/index.jsp?org=SBE

Program/Activity	Type of Assistance	Agency and Contact
National Earthquake Hazards Reduction Program	Funding for research to mitigate earthquake losses by providing earth science data and assessments essential for land use planning, engineering design, and emergency preparedness decisions.	U.S. Geological Survey External Research Support (703) 648-6716 gd-erp-coordinator@usgs.gov http://erp-web.er.usgs.gov
Structural Systems and Hazards Mitigation of Structures	Funding for research on new technologies for improving the behavior and response of structural systems subject to natural hazards.	National Science Foundation Directorate for Engineering Division of Civil, Mechanical, and Manufacturing Innovation (703) 292-8360 www.nsf.gov/div/index.jsp?org=CMMI
Environmental Technology	Funding for research to develop and test new technologies in the field of environmental engineering emphasizing principles underlying pollution avoidance as well as pollution treatment and remediation.	National Science Foundation Directorate for Engineering Division of Chemical, Bioengineering, Environmental, and Transport Systems (703) 292-8320 www.nsf.gov/div/index.jsp?org=CBET
Infrastructure Management and Hazard Response	Funding for research on multidisciplinary issues concerning the impact of natural, technological, and manmade hazards upon critical infrastructure systems and society.	National Science Foundation Directorate for Engineering Division of Civil, Mechanical, and Manufacturing Innovation (703) 292-8360 www.nsf.gov/div/index.jsp?org=CMMI
Environmental Sustainability	Funding for research with the goal of promoting sustainable engineered systems that support human well-being and that also are compatible with sustaining natural (environmental) systems, which provide ecological services vital for human survival.	National Science Foundation Directorate for Engineering Division of Chemical, Bioengineering, Environmental, and Transport Systems (703) 292-8320 www.nsf.gov/div/index.jsp?org=CBET
Behavioral and Social Research on Disasters and Health	Funding for research in the behavioral and social sciences on the consequences of natural and man-made disasters for the health of children, the elderly, and vulnerable groups, with an ultimate goal of preventing or mitigating harmful consequences.	National Institutes of Health (301) 496-4000, TTY (301) 402-9612 NIHinfo@od.nih.gov http://grants.nih.gov/

Program/Activity	Type of Assistance	Agency and Contact
Other Planning Resources: Demographics, Societal Data, and Transportation, Agricultural, Industrial, and Economic Statistics		
Demographics, Societal Statistics and Economic Statistics	Free planning information concerning jobs, business and economic statistics, population and housing statistics, and help with census products (i.e., statistics, maps, reports, etc.). Note: For statistics regarding clean water, wetlands, conservation, disasters, natural resources, rivers, and other subjects covered in this document, use the contact information provided in the subject matter areas.	U.S. Census Bureau (301) 457-4608 www.census.gov/ Bureau of Economic Analysis Public Information Office (202) 606-9900 CustomerService@bea.gov www.bea.gov/ Bureau of Labor Statistics (BLS) Division of Information Services (202) 691-5200, (800) 877-8339 blsdata_staff@bls.gov www.bls.gov/ Mountain-Plains BLS Kansas City Information Office (816) 285-7000, (314) 539-3581 www.bls.gov/ro7/home.htm Missouri Census Data Center Missouri State Library (573) 526-7648 http://mcdc2.missouri.edu/ Center for Entrepreneurship and Outreach University of Missouri–Rolla (573) 341-4690 http://ceo.umr.edu/ Missouri Office of Administration Budget and Planning (573) 751-2345

Program/Activity	Type of Assistance	Agency and Contact
Demographics, Societal Statistics and Economic Statistics (continued)		bpmail@mail.mo.gov www.oa.mo.gov/ Office of Social and Economic Data Analysis University of Missouri–Columbia (573) 882-7396 www.oseda.missouri.edu/ Center for Economic Information University of Missouri–Kansas City (816) 235-1314 http://cei.umkc.edu/ Missouri Agricultural Statistics Service (573) 876-0950, (800) 551-1014 nass-mo@nass.usda.gov www.nass.usda.gov/mo/ Missouri Department of Transportation (573) 751-2551, (888) 275-6636 www.modot.org/ Geographic Resources Center University of Missouri–Columbia (573) 882-1404 www.grc.missouri.edu/ Missouri Economic Research and Information Center (866) 225-8113 MERICData@ded.mo.gov www.ded.mo.gov/researchandplanning/ FedStats www.fedstats.gov/

Program/Activity	Type of Assistance	Agency and Contact
Demographics, Societal Statistics and Economic Statistics (continued)		Missouri Department of Economic Development (573) 751-4962 ecodev@ded.mo.gov http://ded.mo.gov/ Missouri Spatial Data Information Service University of Missouri–Columbia (573) 882-1404 msdismail@missouri.edu http://msdis.missouri.edu/

Appendix B: Demographics

County	Community Name	2000 Census Population	2005 Estimated Population	Estimated Population Numerical Change 2000-2005	Estimated Population Percent Change 2000-2005	2004 Per Capita Personal Income	Rank by 2004 Per Capita Personal Income
Adair	**Countywide**	**24,977**	**24,509**	**-468**	**-1.87%**	**$21,462**	**86**
Adair	Brashear	280	272	-8	-2.86%		
Adair	Gibbs	100	98	-2	-2.00%		
Adair	Greentop*	427	431	4	0.94%		
Adair	Kirksville	16,988	16,986	-2	-0.01%		
Adair	Millard	75	75	0	0.00%		
Adair	Novinger	534	524	-10	-1.87%		
Andrew	**Countywide**	**16,492**	**16,899**	**407**	**2.47%**	**$27,829**	**14**
Andrew	Amazonia	277	287	10	3.61%		
Andrew	Bolckow	234	233	-1	-0.43%		
Andrew	Cosby	143	146	3	2.10%		
Andrew	Country Club	1,846	1,897	51	2.76%		
Andrew	Fillmore	211	215	4	1.90%		
Andrew	Rea	56	57	1	1.79%		
Andrew	Rosendale	180	184	4	2.22%		
Andrew	Savannah	4,762	4,925	163	3.42%		
Atchison	**Countywide**	**6,430**	**6,246**	**-184**	**-2.86%**	**$27,900**	**12**
Atchison	Fairfax	645	622	-23	-3.57%		
Atchison	Rock Port	1,395	1,343	-52	-3.73%		
Atchison	Tarkio	1,935	1,866	-69	-3.57%		
Atchison	Watson	121	119	-2	-1.65%		
Atchison	Westboro	163	162	-1	-0.61%		
Audrain	**Countywide**	**25,853**	**25,759**	**-94**	**-0.36%**	**$23,694**	**60**
Audrain	Benton City	122	124	2	1.64%		
Audrain	Farber	411	397	-14	-3.41%		
Audrain	Laddonia	620	600	-20	-3.23%		
Audrain	Martinsburg	326	328	2	0.61%		
Audrain	Mexico	11,320	11,018	-302	-2.67%		
Audrain	Rush Hill	130	131	1	0.77%		
Audrain	Vandalia	2,529	4,067	1,538	60.81%		
Audrain	Vandiver	83	82	-1	-1.20%		
Barry	**Countywide**	**34,010**	**35,599**	**1,589**	**4.67%**	**$22,566**	**74**
Barry	Arrow Point	133	143	10	7.52%		
Barry	Butterfield	397	416	19	4.79%		
Barry	Cassville	2,890	3,095	205	7.09%		
Barry	Chain-O-Lakes	127	128	1	0.79%		
Barry	Emerald Beach	250	278	28	11.20%		
Barry	Exeter	707	737	30	4.24%		
Barry	Monett*	7,396	8,349	953	12.89%		

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Barry	Purdy	1,103	1,146	43	3.90%		
Barry	Seligman	877	900	23	2.62%		
Barry	Washburn	448	468	20	4.46%		
Barry	Wheaton	721	732	11	1.53%		
Barton	**Countywide**	**12,541**	**13,057**	**516**	**4.11%**	**$22,483**	**75**
Barton	Burgess	70	73	3	4.29%		
Barton	Golden City	884	918	34	3.85%		
Barton	Lamar	4,425	4,602	177	4.00%		
Barton	Lamar Heights	216	228	12	5.56%		
Barton	Liberal	779	811	32	4.11%		
Barton	Milford	52	54	2	3.85%		
Barton	Mindenmines	409	428	19	4.65%		
Bates	**Countywide**	**16,653**	**17,027**	**374**	**2.25%**	**$24,780**	**39**
Bates	Adrian	1,780	1,839	59	3.31%		
Bates	Amoret	211	217	6	2.84%		
Bates	Amsterdam	281	289	8	2.85%		
Bates	Butler	4,209	4,249	40	0.95%		
Bates	Foster	130	133	3	2.31%		
Bates	Hume	337	346	9	2.67%		
Bates	Merwin	83	85	2	2.41%		
Bates	Passaic	40	41	1	2.50%		
Bates	Rich Hill	1,461	1,500	39	2.67%		
Bates	Rockville	162	168	6	3.70%		
Bates	Drexel	1,090	1,115	25	2.29%		
Benton	**Countywide**	**17,180**	**18,854**	**1,674**	**9.74%**	**$21,007**	**91**
Benton	Cole Camp	1,028	1,160	132	12.84%		
Benton	Ionia*	108	115	7	6.48%		
Benton	Lincoln	1,026	1,103	77	7.50%		
Benton	Warsaw	2,070	2,268	198	9.57%		
Bollinger	**Countywide**	**12,029**	**12,325**	**296**	**2.46%**	**$20,266**	**102**
Bollinger	Glen Allen	145	135	-10	-6.90%		
Bollinger	Marble Hill	1,502	1,512	10	0.67%		
Bollinger	Sedgewickville	197	195	-2	-1.02%		
Bollinger	Zalma	93	97	4	4.30%		
Boone	**Countywide**	**135,454**	**143,326**	**7,872**	**5.81%**	**$30,381**	**7**
Boone	Ashland	1,869	2,175	306	16.37%		
Boone	Centralia	3,774	3,657	-117	-3.10%		
Boone	Columbia	84,531	91,814	7,283	8.62%		
Boone	Hallsville	978	955	-23	-2.35%		
Boone	Harrisburg	184	182	-2	-1.09%		
Boone	Hartsburg	108	104	-4	-3.70%		
Boone	McBaine	17	17	0	0.00%		
Boone	Pierpont	(X)	41	41	new		

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Boone	Rocheport	208	201	-7	-3.37%		
Boone	Sturgeon	944	913	-31	-3.28%		
Buchanan	**Countywide**	**85,998**	**84,904**	**-1,094**	**-1.27%**	**$27,368**	**16**
Buchanan	Agency	599	587	-12	-2.00%		
Buchanan	De Kalb	257	258	1	0.39%		
Buchanan	Easton	258	253	-5	-1.94%		
Buchanan	Gower*	1,399	1,433	34	2.43%		
Buchanan	Lewis and Clark Village	155	149	-6	-3.87%		
Buchanan	Rushville	280	268	-12	-4.29%		
Buchanan	St. Joseph	73,990	72,661	-1,329	-1.80%		
Butler	**Countywide**	**40,867**	**41,338**	**471**	**1.15%**	**$25,922**	**25**
Butler	Fisk	363	369	6	1.65%		
Butler	Neelyville	487	503	16	3.29%		
Butler	Poplar Bluff	16,651	16,912	261	1.57%		
Butler	Qulin	467	482	15	3.21%		
Caldwell	**Countywide**	**8,969**	**9,307**	**338**	**3.77%**	**$24,485**	**44**
Caldwell	Braymer	910	962	52	5.71%		
Caldwell	Breckenridge	454	462	8	1.76%		
Caldwell	Cowgill	247	257	10	4.05%		
Caldwell	Hamilton	1,813	1,811	-2	-0.11%		
Caldwell	Kidder	271	283	12	4.43%		
Caldwell	Kingston	287	300	13	4.53%		
Caldwell	Polo	582	602	20	3.44%		
Callaway	**Countywide**	**40,766**	**42,541**	**1,775**	**4.35%**	**$23,151**	**68**
Callaway	Auxvasse	901	996	95	10.54%		
Callaway	Fulton	12,128	12,101	-27	-0.22%		
Callaway	Holts Summit	2,935	3,384	449	15.30%		
Callaway	Jefferson City*	39,636	39,062	-574	-1.45%		
Callaway	Kingdom City	121	137	16	13.22%		
Callaway	Lake Mykee Town	326	342	16	4.91%		
Callaway	Mokane	188	196	8	4.26%		
Callaway	New Bloomfield	599	688	89	14.86%		
Camden	**Countywide**	**37,051**	**39,432**	**2,381**	**6.43%**	**$27,838**	**13**
Camden	Camdenton	2,779	3,061	282	10.15%		
Camden	Climax Springs	80	85	5	6.25%		
Camden	Lake Ozark*	1,489	1,915	426	28.61%		
Camden	Linn Creek	280	295	15	5.36%		
Camden	Macks Creek	267	284	17	6.37%		
Camden	Osage Beach*	3,662	4,259	597	16.30%		
Camden	Richland*	1,805	1,776	-29	-1.61%		
Camden	Stoutland*	177	186	9	5.08%		
Camden	Sunrise Beach	368	389	21	5.71%		

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Camden	Village of Four Seasons	1,493	1,579	86	5.76%		
Cape Girardeau	**Countywide**	**68,693**	**71,161**	**2,468**	**3.59%**	**$28,480**	**10**
Cape Girardeau	Allenville	104	108	4	3.85%		
Cape Girardeau	Cape Girardeau	35,349	36,204	855	2.42%		
Cape Girardeau	Delta	517	536	19	3.68%		
Cape Girardeau	Dutchtown	99	102	3	3.03%		
Cape Girardeau	Gordonville	425	438	13	3.06%		
Cape Girardeau	Jackson	11,947	12,982	1,035	8.66%		
Cape Girardeau	Oak Ridge	202	208	6	2.97%		
Cape Girardeau	Old Appleton	82	85	3	3.66%		
Cape Girardeau	Pocahontas	127	128	1	0.79%		
Cape Girardeau	Whitewater	113	116	3	2.65%		
Carroll	**Countywide**	**10,285**	**10,193**	**-92**	**-0.89%**	**$24,124**	**50**
Carroll	Bogard	234	236	2	0.85%		
Carroll	Bosworth	382	388	6	1.57%		
Carroll	Carrollton	4,122	4,012	-110	-2.67%		
Carroll	De Witt	120	121	1	0.83%		
Carroll	Hale	473	478	5	1.06%		
Carroll	Norborne	805	792	-13	-1.61%		
Carroll	Tina	193	196	3	1.55%		
Carter	**Countywide**	**5,941**	**5,910**	**-31**	**-0.52%**	**$21,365**	**88**
Carter	Ellsinore	363	363	0	0.00%		
Carter	Grandin	236	236	0	0.00%		
Carter	Van Buren	845	817	-28	-3.31%		
Cass	**Countywide**	**82,092**	**94,232**	**12,140**	**14.79%**	**$28,825**	**9**
Cass	Archie	890	958	68	7.64%		
Cass	Baldwin Park	115	122	7	6.09%		
Cass	Belton	21,730	24,140	2,410	11.09%		
Cass	Cleveland	592	674	82	13.85%		
Cass	Creighton	322	350	28	8.70%		
Cass	East Lynne	300	312	12	4.00%		
Cass	Freeman	521	603	82	15.74%		
Cass	Garden City	1,500	1,667	167	11.13%		
Cass	Gunn City	85	88	3	3.53%		
Cass	Harrisonville	8,946	9,790	844	9.43%		
Cass	Lake Annette	163	168	5	3.07%		
Cass	Lake Winnebago	902	1,065	163	18.07%		
Cass	Lee's Summit*	70,700	80,338	9,638	13.63%		
Cass	Loch Lloyd	(X)	382	382	new		
Cass	Peculiar	2,604	3,832	1,228	47.16%		
Cass	Pleasant Hill	5,582	6,747	1,165	20.87%		
Cass	Raymore	11,146	15,530	4,384	39.33%		

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Cass	Strasburg	136	140	4	2.94%		
Cass	Kansas City*	441,545	444,965	3,420	0.77%		
Cedar	**Countywide**	**13,733**	**14,160**	**427**	**3.11%**	**$20,638**	**98**
Cedar	El Dorado Springs	3,775	3,849	74	1.96%		
Cedar	Jerico Springs	259	270	11	4.25%		
Cedar	Stockton	1,960	2,004	44	2.24%		
Cedar	Umber View Heights	52	59	7	13.46%		
Chariton	**Countywide**	**8,438**	**8,124**	**-314**	**-3.72%**	**$25,304**	**29**
Chariton	Brunswick	925	895	-30	-3.24%		
Chariton	Dalton	27	26	-1	-3.70%		
Chariton	Keytesville	533	516	-17	-3.19%		
Chariton	Marceline*	2,558	2,405	-153	-5.98%		
Chariton	Mendon	208	201	-7	-3.37%		
Chariton	Rothville	93	90	-3	-3.23%		
Chariton	Salisbury	1,726	1,635	-91	-5.27%		
Chariton	Sumner	142	138	-4	-2.82%		
Chariton	Triplett	64	62	-2	-3.13%		
Christian	**Countywide**	**54,285**	**67,266**	**12,981**	**23.91%**	**$24,500**	**43**
Christian	Billings	1,091	1,142	51	4.67%		
Christian	Clever	1,010	1,242	232	22.97%		
Christian	Fremont Hills	597	624	27	4.52%		
Christian	Highlandville	872	921	49	5.62%		
Christian	Nixa	12,124	15,925	3,801	31.35%		
Christian	Ozark	9,665	15,265	5,600	57.94%		
Christian	Sparta	1,144	1,226	82	7.17%		
Clark	**Countywide**	**7,416**	**7,323**	**-93**	**-1.25%**	**$22,958**	**73**
Clark	Alexandria	166	169	3	1.81%		
Clark	Kahoka	2,241	2,193	-48	-2.14%		
Clark	Luray	102	102	0	0.00%		
Clark	Revere	121	116	-5	-4.13%		
Clark	Wayland	425	407	-18	-4.24%		
Clark	Wyaconda	310	300	-10	-3.23%		
Clay	**Countywide**	**184,006**	**202,078**	**18,072**	**9.82%**	**$33,133**	**4**
Clay	Avondale	529	529	0	0.00%		
Clay	Birmingham	214	214	0	0.00%		
Clay	Claycomo	1,267	1,280	13	1.03%		
Clay	Excelsior Estates*	263	274	11	4.18%		
Clay	Excelsior Springs*	10,847	11,472	625	5.76%		
Clay	Gladstone	26,365	27,306	941	3.57%		
Clay	Glenaire	553	587	34	6.15%		
Clay	Holt	405	436	31	7.65%		
Clay	Kansas City*	441,545	444,965	3,420	0.77%		

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Clay	Kearney	5,472	7,399	1,927	35.22%		
Clay	Lawson*	2,336	2,406	70	3.00%		
Clay	Liberty	26,232	29,042	2,810	10.71%		
Clay	Missouri City	295	323	28	9.49%		
Clay	Mosby	242	243	1	0.41%		
Clay	North Kansas City	4,714	5,388	674	14.30%		
Clay	Oaks	136	136	0	0.00%		
Clay	Oakview	386	386	0	0.00%		
Clay	Oakwood	197	200	3	1.52%		
Clay	Oakwood Park	183	177	-6	-3.28%		
Clay	Pleasant Valley	3,321	3,445	124	3.73%		
Clay	Prathersville	111	128	17	15.32%		
Clay	Randolph	47	49	2	4.26%		
Clay	Smithville	5,514	7,118	1,604	29.09%		
Clay	Sugar Creek*	3,839	3,598	-241	-6.28%		
Clinton	**Countywide**	**18,979**	**20,715**	**1,736**	**9.15%**	**$26,486**	**22**
Clinton	Cameron*	8,312	9,141	829	9.97%		
Clinton	Lathrop	2,092	2,328	236	11.28%		
Clinton	Plattsburg	2,354	2,442	88	3.74%		
Clinton	Trimble	451	485	34	7.54%		
Clinton	Turney	155	161	6	3.87%		
Clinton	Gower*	1,399	1,433	34	2.43%		
Clinton	Osborn*	455	448	-7	-1.54%		
Cole	**Countywide**	**71,397**	**72,757**	**1,360**	**1.90%**	**$33,873**	**3**
Cole	Centertown	257	251	-6	-2.33%		
Cole	Lohman	168	164	-4	-2.38%		
Cole	Russellville	758	735	-23	-3.03%		
Cole	St. Martins	1,023	1,077	54	5.28%		
Cole	St. Thomas	287	285	-2	-0.70%		
Cole	Taos	870	862	-8	-0.92%		
Cole	Wardsville	976	967	-9	-0.92%		
Cole	Jefferson City*	39,636	39,062	-574	-1.45%		
Cooper	**Countywide**	**16,670**	**17,294**	**624**	**3.74%**	**$23,297**	**65**
Cooper	Blackwater	199	197	-2	-1.01%		
Cooper	Boonville	8,202	8,669	467	5.69%		
Cooper	Bunceton	348	357	9	2.59%		
Cooper	Otterville	476	486	10	2.10%		
Cooper	Pilot Grove	723	739	16	2.21%		
Cooper	Prairie Home	220	225	5	2.27%		
Cooper	Wooldridge	47	43	-4	-8.51%		
Crawford	**Countywide**	**22,804**	**23,932**	**1,128**	**4.95%**	**$24,334**	**47**
Crawford	Bourbon	1,348	1,408	60	4.45%		
Crawford	Cuba	3,230	3,447	217	6.72%		

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Crawford	Leasburg	323	341	18	5.57%		
Crawford	St. Cloud	56	60	4	7.14%		
Crawford	Steelville	1,429	1,454	25	1.75%		
Crawford	Sullivan*	6,351	6,613	262	4.13%		
Crawford	West Sullivan	(X)	82	82	new		
Dade	**Countywide**	**7,923**	**7,830**	**-93**	**-1.17%**	**$23,151**	**68**
Dade	Arcola	45	45	0	0.00%		
Dade	Dadeville	224	224	0	0.00%		
Dade	Everton	322	322	0	0.00%		
Dade	Greenfield	1,358	1,299	-59	-4.34%		
Dade	Lockwood	989	962	-27	-2.73%		
Dade	South Greenfield	136	136	0	0.00%		
Dallas	**Countywide**	**15,661**	**16,437**	**776**	**4.95%**	**$22,223**	**78**
Dallas	Buffalo	2,781	3,006	225	8.09%		
Dallas	Louisburg	147	154	7	4.76%		
Dallas	Urbana	407	426	19	4.67%		
Daviess	**Countywide**	**8,016**	**8,121**	**105**	**1.31%**	**$23,003**	**71**
Daviess	Altamont	218	224	6	2.75%		
Daviess	Coffey	140	144	4	2.86%		
Daviess	Gallatin	1,789	1,776	-13	-0.73%		
Daviess	Jameson	120	123	3	2.50%		
Daviess	Jamesport	505	516	11	2.18%		
Daviess	Lock Springs	69	70	1	1.45%		
Daviess	Pattonsburg	261	243	-18	-6.90%		
Daviess	Winston	247	253	6	2.43%		
DeKalb	**Countywide**	**11,597**	**12,342**	**745**	**6.42%**	**$16,639**	**115**
DeKalb	Amity	70	68	-2	-2.86%		
DeKalb	Clarksdale	351	343	-8	-2.28%		
DeKalb	Maysville	1,212	1,165	-47	-3.88%		
DeKalb	Osborn*	455	448	-7	-1.54%		
DeKalb	Stewartsville	759	746	-13	-1.71%		
DeKalb	Union Star	433	412	-21	-4.85%		
DeKalb	Weatherby	123	121	-2	-1.63%		
DeKalb	Cameron*	8,312	9,141	829	9.97%		
Dent	**Countywide**	**14,927**	**15,083**	**156**	**1.05%**	**$20,697**	**96**
Dent	Bunker*	427	437	10	2.34%		
Dent	Salem	4,854	4,789	-65	-1.34%		
Douglas	**Countywide**	**13,084**	**13,594**	**510**	**3.90%**	**$19,232**	**107**
Douglas	Ava	3,021	3,078	57	1.89%		
Dunklin	**Countywide**	**33,155**	**32,545**	**-610**	**-1.84%**	**$23,579**	**62**
Dunklin	Arbyrd	528	507	-21	-3.98%		
Dunklin	Campbell	1,883	1,872	-11	-0.58%		
Dunklin	Cardwell	789	751	-38	-4.82%		

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Dunklin	Clarkton	1,330	1,280	-50	-3.76%		
Dunklin	Holcomb	696	697	1	0.14%		
Dunklin	Hornersville	686	681	-5	-0.73%		
Dunklin	Kennett	11,260	11,028	-232	-2.06%		
Dunklin	Malden	4,782	4,635	-147	-3.07%		
Dunklin	Rives	88	89	1	1.14%		
Dunklin	Senath	1,650	1,641	-9	-0.55%		
Franklin	**Countywide**	**93,807**	**99,090**	**5,283**	**5.63%**	**$28,130**	**11**
Franklin	Berger	206	208	2	0.97%		
Franklin	Gerald	1,171	1,238	67	5.72%		
Franklin	Leslie	87	89	2	2.30%		
Franklin	Miramiguoa Park	127	128	1	0.79%		
Franklin	New Haven	1,867	1,950	83	4.45%		
Franklin	Oak Grove	382	385	3	0.79%		
Franklin	Pacific*	5,482	7,098	1,616	29.48%		
Franklin	Parkway	280	283	3	1.07%		
Franklin	St. Clair	4,390	4,405	15	0.34%		
Franklin	Union	7,757	8,897	1,140	14.70%		
Franklin	Washington	13,243	14,136	893	6.74%		
Franklin	Sullivan*	6,351	6,613	262	4.13%		
Gasconade	**Countywide**	**15,342**	**15,745**	**403**	**2.63%**	**$24,122**	**51**
Gasconade	Bland	565	571	6	1.06%		
Gasconade	Gasconade	267	267	0	0.00%		
Gasconade	Hermann	2,674	2,735	61	2.28%		
Gasconade	Morrison	123	126	3	2.44%		
Gasconade	Owensville	2,500	2,544	44	1.76%		
Gasconade	Rosebud	364	373	9	2.47%		
Gentry	**Countywide**	**6,861**	**6,555**	**-306**	**-4.46%**	**$24,848**	**37**
Gentry	Albany	1,937	1,832	-105	-5.42%		
Gentry	Darlington	113	110	-3	-2.65%		
Gentry	Gentry	101	99	-2	-1.98%		
Gentry	King City	1,012	944	-68	-6.72%		
Gentry	McFall	135	131	-4	-2.96%		
Gentry	Stanberry	1,243	1,192	-51	-4.10%		
Greene	**Countywide**	**240,391**	**250,784**	**10,393**	**4.32%**	**$29,727**	**8**
Greene	Ash Grove	1,430	1,491	61	4.27%		
Greene	Battlefield	2,385	3,612	1,227	51.45%		
Greene	Brookline	326	371	45	13.80%		
Greene	Fair Grove	1,107	1,283	176	15.90%		
Greene	Republic	8,438	10,637	2,199	26.06%		
Greene	Springfield	151,580	150,298	-1,282	-0.85%		
Greene	Strafford	1,845	1,909	64	3.47%		
Greene	Walnut Grove	630	626	-4	-0.63%		

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Greene	Willard	3,193	3,330	137	4.29%		
Greene	Rogersville*	1,508	2,239	731	48.47%		
Grundy	**Countywide**	**10,432**	**10,327**	**-105**	**-1.01%**	**$22,156**	**79**
Grundy	Brimson	63	63	0	0.00%		
Grundy	Galt	275	275	0	0.00%		
Grundy	Laredo	250	249	-1	-0.40%		
Grundy	Spickard	315	314	-1	-0.32%		
Grundy	Tindall	65	66	1	1.54%		
Grundy	Trenton	6,216	6,121	-95	-1.53%		
Harrison	**Countywide**	**8,850**	**8,876**	**26**	**0.29%**	**$21,734**	**84**
Harrison	Bethany	3,087	3,060	-27	-0.87%		
Harrison	Blythedale	233	236	3	1.29%		
Harrison	Cainsville	370	373	3	0.81%		
Harrison	Eagleville	321	326	5	1.56%		
Harrison	Gilman City	380	383	3	0.79%		
Harrison	Mount Moriah	143	145	2	1.40%		
Harrison	New Hampton	349	351	2	0.57%		
Harrison	Ridgeway	530	536	6	1.13%		
Henry	**Countywide**	**21,997**	**22,577**	**580**	**2.64%**	**$24,967**	**33**
Henry	Blairstown	141	145	4	2.84%		
Henry	Brownington	119	124	5	4.20%		
Henry	Calhoun	491	508	17	3.46%		
Henry	Clinton	9,311	9,414	103	1.11%		
Henry	Deepwater	507	505	-2	-0.39%		
Henry	Montrose	417	431	14	3.36%		
Henry	Tightwad	63	66	3	4.76%		
Henry	Urich	499	516	17	3.41%		
Henry	Windsor*	3,087	3,265	178	5.77%		
Hickory	**Countywide**	**8,940**	**9,271**	**331**	**3.70%**	**$17,888**	**113**
Hickory	Cross Timbers	185	191	6	3.24%		
Hickory	Hermitage	406	509	103	25.37%		
Hickory	Preston	113	117	4	3.54%		
Hickory	Weaubleau	518	536	18	3.47%		
Hickory	Wheatland	388	402	14	3.61%		
Holt	**Countywide**	**5,351**	**5,081**	**-270**	**-5.05%**	**$25,212**	**30**
Holt	Bigelow	38	37	-1	-2.63%		
Holt	Big Lake	127	122	-5	-3.94%		
Holt	Corning	21	20	-1	-4.76%		
Holt	Craig	309	297	-12	-3.88%		
Holt	Forest City	338	324	-14	-4.14%		
Holt	Fortescue	51	49	-2	-3.92%		
Holt	Maitland	342	315	-27	-7.89%		
Holt	Mound City	1,193	1,110	-83	-6.96%		

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Holt	Oregon	935	901	-34	-3.64%		
Howard	**Countywide**	**10,212**	**9,957**	**-255**	**-2.50%**	**$24,870**	**35**
Howard	Armstrong	287	283	-4	-1.39%		
Howard	Fayette	2,793	2,701	-92	-3.29%		
Howard	Franklin	112	112	0	0.00%		
Howard	Glasgow	1,263	1,205	-58	-4.59%		
Howard	New Franklin	1,145	1,113	-32	-2.79%		
Howell	**Countywide**	**37,238**	**38,400**	**1,162**	**3.12%**	**$21,565**	**85**
Howell	Brandsville	174	180	6	3.45%		
Howell	Mountain View	2,430	2,546	116	4.77%		
Howell	West Plains	10,866	11,348	482	4.44%		
Howell	Willow Springs	2,147	2,116	-31	-1.44%		
Iron	**Countywide**	**10,697**	**10,273**	**-424**	**-3.96%**	**$21,035**	**90**
Iron	Annapolis	310	298	-12	-3.87%		
Iron	Arcadia	567	532	-35	-6.17%		
Iron	Des Arc	187	194	7	3.74%		
Iron	Ironton	1,471	1,362	-109	-7.41%		
Iron	Pilot Knob	697	684	-13	-1.87%		
Iron	Viburnum	825	811	-14	-1.70%		
Jackson	**Countywide**	**654,880**	**662,959**	**8,079**	**1.23%**	**$32,413**	**6**
Jackson	Blue Springs	48,080	53,099	5,019	10.44%		
Jackson	Buckner	2,725	2,724	-1	-0.04%		
Jackson	Grain Valley	5,160	8,644	3,484	67.52%		
Jackson	Grandview	24,881	24,549	-332	-1.33%		
Jackson	Greenwood	3,952	4,512	560	14.17%		
Jackson	Independence	113,288	110,208	-3,080	-2.72%		
Jackson	Lake Lotawana	1,872	1,921	49	2.62%		
Jackson	Lake Tapawingo	843	809	-34	-4.03%		
Jackson	Levasy	108	100	-8	-7.41%		
Jackson	Lone Jack	528	697	169	32.01%		
Jackson	Oak Grove*	5,535	6,763	1,228	22.19%		
Jackson	Raytown	30,388	28,923	-1,465	-4.82%		
Jackson	River Bend	10	9	-1	-10.00%		
Jackson	Sibley	347	338	-9	-2.59%		
Jackson	Sugar Creek*	3,839	3,598	-241	-6.28%		
Jackson	Unity Village	140	117	-23	-16.43%		
Jackson	Kansas City*	441,545	444,965	3,420	0.77%		
Jackson	Lee's Summit*	70,700	80,338	9,638	13.63%		
Jasper	**Countywide**	**104,686**	**110,624**	**5,938**	**5.67%**	**$24,855**	**36**
Jasper	Airport Drive	622	679	57	9.16%		
Jasper	Alba	588	612	24	4.08%		
Jasper	Asbury	218	226	8	3.67%		
Jasper	Avilla	137	142	5	3.65%		

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Jasper	Brooklyn Heights	125	130	5	4.00%		
Jasper	Carl Junction	5,294	6,483	1,189	22.46%		
Jasper	Carterville	1,850	1,916	66	3.57%		
Jasper	Carthage	12,668	13,096	428	3.38%		
Jasper	Carytown	217	225	8	3.69%		
Jasper	Duenweg	1,034	1,068	34	3.29%		
Jasper	Duquesne	1,640	1,692	52	3.17%		
Jasper	Fidelity	252	263	11	4.37%		
Jasper	Jasper	1,011	1,037	26	2.57%		
Jasper	Joplin*	45,504	47,183	1,679	3.69%		
Jasper	La Russell	138	144	6	4.35%		
Jasper	Neck City	119	124	5	4.20%		
Jasper	Oronogo	976	1,831	855	87.60%		
Jasper	Purcell	357	372	15	4.20%		
Jasper	Reeds	103	108	5	4.85%		
Jasper	Sarcoxie	1,354	1,340	-14	-1.03%		
Jasper	Waco	86	90	4	4.65%		
Jasper	Webb City	9,812	10,764	952	9.70%		
Jefferson	**Countywide**	**198,099**	**213,669**	**15,570**	**7.86%**	**$27,164**	**18**
Jefferson	Arnold	19,965	20,413	448	2.24%		
Jefferson	Byrnes Mill	2,376	2,746	370	15.57%		
Jefferson	Cedar Hill Lakes	229	221	-8	-3.49%		
Jefferson	Crystal City	4,247	4,508	261	6.15%		
Jefferson	De Soto	6,375	6,552	177	2.78%		
Jefferson	Festus	9,660	10,905	1,245	12.89%		
Jefferson	Herculaneum	2,805	3,172	367	13.08%		
Jefferson	Hillsboro	1,675	1,784	109	6.51%		
Jefferson	Kimmswick	94	93	-1	-1.06%		
Jefferson	Olympian Village	669	677	8	1.20%		
Jefferson	Parkdale	205	201	-4	-1.95%		
Jefferson	Pevely	3,768	4,208	440	11.68%		
Jefferson	Scotsdale	211	215	4	1.90%		
Jefferson	Pacific*	5,482	7,098	1,616	29.48%		
Johnson	**Countywide**	**48,258**	**50,784**	**2,526**	**5.23%**	**$23,560**	**63**
Johnson	Centerview	249	258	9	3.61%		
Johnson	Chilhowee	329	340	11	3.34%		
Johnson	Holden	2,510	2,543	33	1.31%		
Johnson	Kingsville	257	260	3	1.17%		
Johnson	Knob Noster	2,462	2,734	272	11.05%		
Johnson	La Tour	65	67	2	3.08%		
Johnson	Leeton	619	626	7	1.13%		
Johnson	Warrensburg	16,340	17,769	1,429	8.75%		
Knox	**Countywide**	**4,361**	**4,171**	**-190**	**-4.36%**	**$24,004**	**54**

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Knox	Baring	159	153	-6	-3.77%		
Knox	Edina	1,233	1,162	-71	-5.76%		
Knox	Hurdland	239	232	-7	-2.93%		
Knox	Knox City	223	215	-8	-3.59%		
Knox	Newark	100	96	-4	-4.00%		
Knox	Novelty	119	114	-5	-4.20%		
Laclede	**Countywide**	**32,513**	**34,492**	**1,979**	**6.09%**	**$22,050**	**80**
Laclede	Conway	743	774	31	4.17%		
Laclede	Evergreen	(X)	65	65	new		
Laclede	Lebanon	12,155	13,336	1,181	9.72%		
Laclede	Phillipsburg	201	225	24	11.94%		
Laclede	Richland*	1,805	1,776	-29	-1.61%		
Laclede	Stoutland*	177	186	9	5.08%		
Lafayette	**Countywide**	**32,960**	**33,108**	**148**	**0.45%**	**$27,534**	**15**
Lafayette	Alma	399	378	-21	-5.26%		
Lafayette	Aullville	86	86	0	0.00%		
Lafayette	Bates City	245	240	-5	-2.04%		
Lafayette	Blackburn*	284	278	-6	-2.11%		
Lafayette	Concordia	2,360	2,413	53	2.25%		
Lafayette	Corder	427	426	-1	-0.23%		
Lafayette	Dover	108	108	0	0.00%		
Lafayette	Emma*	243	239	-4	-1.65%		
Lafayette	Higginsville	4,682	4,660	-22	-0.47%		
Lafayette	Lake Lafayette	346	374	28	8.09%		
Lafayette	Lexington	4,453	4,632	179	4.02%		
Lafayette	Mayview	294	294	0	0.00%		
Lafayette	Napoleon	208	202	-6	-2.88%		
Lafayette	Odessa	4,818	4,841	23	0.48%		
Lafayette	Waverly	806	807	1	0.12%		
Lafayette	Wellington	784	783	-1	-0.13%		
Lafayette	Oak Grove*	5,535	6,763	1,228	22.19%		
Lawrence	**Countywide**	**35,204**	**37,127**	**1,923**	**5.46%**	**$20,712**	**95**
Lawrence	Aurora	7,014	7,307	293	4.18%		
Lawrence	Freistatt	184	193	9	4.89%		
Lawrence	Halltown	189	200	11	5.82%		
Lawrence	Hoberg	60	63	3	5.00%		
Lawrence	Marionville	2,113	2,161	48	2.27%		
Lawrence	Miller	754	792	38	5.04%		
Lawrence	Mount Vernon	4,017	4,402	385	9.58%		
Lawrence	Pierce City	1,385	1,442	57	4.12%		
Lawrence	Stotts City	250	265	15	6.00%		
Lawrence	Verona	714	720	6	0.84%		
Lawrence	Monett*	7,396	8,349	953	12.89%		

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Lewis	**Countywide**	**10,494**	**10,186**	**-308**	**-2.94%**	**$20,837**	**93**
Lewis	Canton	2,557	2,502	-55	-2.15%		
Lewis	Ewing	464	453	-11	-2.37%		
Lewis	La Belle	669	666	-3	-0.45%		
Lewis	La Grange	1,000	949	-51	-5.10%		
Lewis	Lewistown	595	580	-15	-2.52%		
Lewis	Monticello	126	122	-4	-3.17%		
Lincoln	**Countywide**	**38,944**	**47,727**	**8,783**	**22.55%**	**$24,504**	**42**
Lincoln	Cave	7	8	1	14.29%		
Lincoln	Chain of Rocks	91	107	16	17.58%		
Lincoln	Elsberry	2,047	2,417	370	18.08%		
Lincoln	Foley	178	199	21	11.80%		
Lincoln	Fountain N' Lakes	129	157	28	21.71%		
Lincoln	Hawk Point	459	524	65	14.16%		
Lincoln	Moscow Mills	1,742	2,232	490	28.13%		
Lincoln	Old Monroe	250	283	33	13.20%		
Lincoln	Silex	206	232	26	12.62%		
Lincoln	Troy	6,737	9,862	3,125	46.39%		
Lincoln	Truxton	96	112	16	16.67%		
Lincoln	Whiteside	67	80	13	19.40%		
Lincoln	Winfield	723	850	127	17.57%		
Linn	**Countywide**	**13,754**	**13,133**	**-621**	**-4.52%**	**$23,620**	**61**
Linn	Brookfield	4,769	4,506	-263	-5.51%		
Linn	Browning	317	307	-10	-3.15%		
Linn	Bucklin	524	496	-28	-5.34%		
Linn	Laclede	415	406	-9	-2.17%		
Linn	Linneus	369	358	-11	-2.98%		
Linn	Meadville	457	443	-14	-3.06%		
Linn	Purdin	223	215	-8	-3.59%		
Linn	Marceline*	2,558	2,405	-153	-5.98%		
Livingston	**Countywide**	**14,558**	**14,291**	**-267**	**-1.83%**	**$25,672**	**27**
Livingston	Chillicothe	8,968	8,686	-282	-3.14%		
Livingston	Chula	198	201	3	1.52%		
Livingston	Ludlow	204	198	-6	-2.94%		
Livingston	Mooresville	89	86	-3	-3.37%		
Livingston	Utica	274	268	-6	-2.19%		
Livingston	Wheeling	268	261	-7	-2.61%		
Macon	**Countywide**	**15,762**	**15,600**	**-162**	**-1.03%**	**$23,782**	**59**
Macon	Atlanta	450	453	3	0.67%		
Macon	Bevier	723	729	6	0.83%		
Macon	Callao	291	279	-12	-4.12%		
Macon	Elmer	98	98	0	0.00%		
Macon	Ethel	100	100	0	0.00%		

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Macon	La Plata	1,486	1,442	-44	-2.96%		
Macon	Macon	5,538	5,428	-110	-1.99%		
Macon	New Cambria	222	223	1	0.45%		
Macon	South Gifford	72	72	0	0.00%		
Madison	**Countywide**	**11,800**	**12,151**	**351**	**2.97%**	**$20,037**	**103**
Madison	Cobalt	189	195	6	3.17%		
Madison	Fredericktown	3,928	4,035	107	2.72%		
Madison	Junction City	319	333	14	4.39%		
Madison	Marquand	251	266	15	5.98%		
Maries	**Countywide**	**8,903**	**8,989**	**86**	**0.97%**	**$22,960**	**72**
Maries	Argyle*	164	169	5	3.05%		
Maries	Belle	1,344	1,348	4	0.30%		
Maries	Vienna*	628	635	7	1.11%		
Marion	**Countywide**	**28,289**	**28,375**	**86**	**0.30%**	**$24,621**	**41**
Marion	Hannibal*	17,757	17,649	-108	-0.61%		
Marion	Monroe City*	2,588	2,556	-32	-1.24%		
Marion	Palmyra	3,467	3,443	-24	-0.69%		
McDonald	**Countywide**	**21,681**	**22,844**	**1,163**	**5.36%**	**$21,279**	**89**
McDonald	Anderson	1,856	1,902	46	2.48%		
McDonald	Goodman	1,183	1,233	50	4.23%		
McDonald	Lanagan	411	435	24	5.84%		
McDonald	Noel	1,480	1,515	35	2.36%		
McDonald	Pineville	768	868	100	13.02%		
McDonald	South West City	855	919	64	7.49%		
Mercer	**Countywide**	**3,757**	**3,595**	**-162**	**-4.31%**	**$25,460**	**28**
Mercer	Mercer	342	330	-12	-3.51%		
Mercer	Princeton	1,047	969	-78	-7.45%		
Mercer	South Lineville	37	36	-1	-2.70%		
Miller	**Countywide**	**23,564**	**24,712**	**1,148**	**4.87%**	**$20,688**	**97**
Miller	Bagnell	86	91	5	5.81%		
Miller	Brumley	102	108	6	5.88%		
Miller	Eldon	4,895	4,934	39	0.80%		
Miller	Iberia	605	673	68	11.24%		
Miller	Lakeside	37	38	1	2.70%		
Miller	Olean	157	163	6	3.82%		
Miller	St. Elizabeth	297	305	8	2.69%		
Miller	Tuscumbia	218	223	5	2.29%		
Miller	Lake Ozark*	1,489	1,915	426	28.61%		
Miller	Osage Beach*	3,662	4,259	597	16.30%		
Mississippi	**Countywide**	**13,427**	**13,599**	**172**	**1.28%**	**$21,754**	**83**
Mississippi	Anniston	285	275	-10	-3.51%		
Mississippi	Bertrand	740	710	-30	-4.05%		
Mississippi	Charleston	4,732	5,129	397	8.39%		

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Mississippi	East Prairie	3,227	3,117	-110	-3.41%		
Mississippi	Pinhook	48	48	0	0.00%		
Mississippi	Wilson City	165	165	0	0.00%		
Mississippi	Wyatt	364	345	-19	-5.22%		
Mississippi	Miner*	1,056	1,268	212	20.08%		
Moniteau	**Countywide**	**14,827**	**15,084**	**257**	**1.73%**	**$23,865**	**57**
Moniteau	California	4,005	4,137	132	3.30%		
Moniteau	Clarksburg	375	390	15	4.00%		
Moniteau	Jamestown	382	397	15	3.93%		
Moniteau	Lupus	29	30	1	3.45%		
Moniteau	Tipton	3,261	3,142	-119	-3.65%		
Monroe	**Countywide**	**9,311**	**9,379**	**68**	**0.73%**	**$23,163**	**67**
Monroe	Goss	(X)	1	1	new		
Monroe	Holliday	129	129	0	0.00%		
Monroe	Madison	586	562	-24	-4.10%		
Monroe	Paris	1,529	1,468	-61	-3.99%		
Monroe	Stoutsville	44	44	0	0.00%		
Monroe	Monroe City*	2,588	2,556	-32	-1.24%		
Montgomery	**Countywide**	**12,136**	**12,166**	**30**	**0.25%**	**$24,806**	**38**
Montgomery	Bellflower	427	414	-13	-3.04%		
Montgomery	High Hill	231	226	-5	-2.16%		
Montgomery	Jonesburg	695	707	12	1.73%		
Montgomery	McKittrick	72	70	-2	-2.78%		
Montgomery	Middletown	199	191	-8	-4.02%		
Montgomery	Montgomery City	2,442	2,513	71	2.91%		
Montgomery	New Florence	764	777	13	1.70%		
Montgomery	Rhineland	176	173	-3	-1.70%		
Montgomery	Wellsville	1,423	1,398	-25	-1.76%		
Morgan	**Countywide**	**19,309**	**20,436**	**1,127**	**5.84%**	**$23,100**	**70**
Morgan	Barnett	207	225	18	8.70%		
Morgan	Gravois Mills	208	225	17	8.17%		
Morgan	Laurie	663	703	40	6.03%		
Morgan	Stover	968	1,022	54	5.58%		
Morgan	Syracuse	172	183	11	6.40%		
Morgan	Versailles	2,565	2,662	97	3.78%		
Morgan	Sunrise Beach	368	389	21	5.71%		
New Madrid	**Countywide**	**19,760**	**18,566**	**-1,194**	**-6.04%**	**$23,869**	**56**
New Madrid	Canalou	348	320	-28	-8.05%		
New Madrid	Catron	68	65	-3	-4.41%		
New Madrid	Gideon	1,113	1,019	-94	-8.45%		
New Madrid	Howardville	342	335	-7	-2.05%		
New Madrid	Lilbourn	1,303	1,237	-66	-5.07%		
New Madrid	Marston	610	563	-47	-7.70%		

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New Madrid	Matthews	605	552	-53	-8.76%		
New Madrid	Morehouse	1,015	960	-55	-5.42%		
New Madrid	New Madrid	3,334	3,131	-203	-6.09%		
New Madrid	North Lilbourn	95	90	-5	-5.26%		
New Madrid	Parma	852	805	-47	-5.52%		
New Madrid	Portageville	3,295	3,071	-224	-6.80%		
New Madrid	Risco	392	364	-28	-7.14%		
New Madrid	Sikeston*	16,992	17,180	188	1.11%		
New Madrid	Tallapoosa	204	195	-9	-4.41%		
Newton	**Countywide**	**52,636**	**55,554**	**2,918**	**5.54%**	**$24,348**	**46**
Newton	Cliff Village	33	34	1	3.03%		
Newton	Dennis Acres	68	74	6	8.82%		
Newton	Diamond	807	846	39	4.83%		
Newton	Fairview	395	415	20	5.06%		
Newton	Granby	2,121	2,230	109	5.14%		
Newton	Grand Falls Plaza	104	109	5	4.81%		
Newton	Leawood	904	955	51	5.64%		
Newton	Loma Linda	507	601	94	18.54%		
Newton	Neosho	10,505	11,130	625	5.95%		
Newton	Newtonia	231	243	12	5.19%		
Newton	Redings Mill	159	166	7	4.40%		
Newton	Ritchey	76	80	4	5.26%		
Newton	Saginaw	276	306	30	10.87%		
Newton	Seneca	2,135	2,237	102	4.78%		
Newton	Shoal Creek Drive	346	358	12	3.47%		
Newton	Shoal Creek Estates	51	54	3	5.88%		
Newton	Silver Creek	608	634	26	4.28%		
Newton	Stark City	156	164	8	5.13%		
Newton	Stella	178	187	9	5.06%		
Newton	Wentworth	141	148	7	4.96%		
Newton	Joplin*	45,504	47,183	1,679	3.69%		
Nodaway	**Countywide**	**21,912**	**21,710**	**-202**	**-0.92%**	**$22,230**	**77**
Nodaway	Arkoe	58	58	0	0.00%		
Nodaway	Barnard	257	250	-7	-2.72%		
Nodaway	Burlington Junction	632	613	-19	-3.01%		
Nodaway	Clearmont	191	185	-6	-3.14%		
Nodaway	Clyde	74	73	-1	-1.35%		
Nodaway	Conception Junction	202	197	-5	-2.48%		
Nodaway	Elmo	166	161	-5	-3.01%		
Nodaway	Graham	191	186	-5	-2.62%		
Nodaway	Guilford	87	84	-3	-3.45%		

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Nodaway	Hopkins	579	561	-18	-3.11%		
Nodaway	Maryville	10,581	10,567	-14	-0.13%		
Nodaway	Parnell	197	191	-6	-3.05%		
Nodaway	Pickering	154	149	-5	-3.25%		
Nodaway	Quitman	46	45	-1	-2.17%		
Nodaway	Ravenwood	448	439	-9	-2.01%		
Nodaway	Skidmore	342	331	-11	-3.22%		
Oregon	**Countywide**	**10,344**	**10,403**	**59**	**0.57%**	**$18,732**	**110**
Oregon	Alton	668	648	-20	-2.99%		
Oregon	Koshkonong	205	208	3	1.46%		
Oregon	Thayer	2,201	2,171	-30	-1.36%		
Osage	**Countywide**	**13,062**	**13,485**	**423**	**3.24%**	**$27,304**	**17**
Osage	Argyle*	164	169	5	3.05%		
Osage	Belle*	1,344	1,348	4	0.30%		
Osage	Chamois	456	473	17	3.73%		
Osage	Freeburg	423	439	16	3.78%		
Osage	Linn	1,354	1,424	70	5.17%		
Osage	Meta	249	258	9	3.61%		
Osage	Westphalia	320	331	11	3.44%		
Ozark	**Countywide**	**9,542**	**9,490**	**-52**	**-0.54%**	**$18,809**	**109**
Ozark	Bakersfield	285	286	1	0.35%		
Ozark	Gainesville	632	607	-25	-3.96%		
Ozark	Theodosia	240	253	13	5.42%		
Pemiscot	**Countywide**	**20,047**	**19,412**	**-635**	**-3.17%**	**$23,230**	**66**
Pemiscot	Bragg City	189	188	-1	-0.53%		
Pemiscot	Caruthersville	6,760	6,450	-310	-4.59%		
Pemiscot	Cooter	440	437	-3	-0.68%		
Pemiscot	Hayti	3,207	3,066	-141	-4.40%		
Pemiscot	Hayti Heights	771	781	10	1.30%		
Pemiscot	Holland	246	244	-2	-0.81%		
Pemiscot	Homestown	181	179	-2	-1.10%		
Pemiscot	North Wardell	170	169	-1	-0.59%		
Pemiscot	Pascola	138	139	1	0.72%		
Pemiscot	Steele	2,263	2,169	-94	-4.15%		
Pemiscot	Wardell	278	262	-16	-5.76%		
Perry	**Countywide**	**18,132**	**18,571**	**439**	**2.42%**	**$24,127**	**49**
Perry	Altenburg	309	315	6	1.94%		
Perry	Frohna	192	201	9	4.69%		
Perry	Longtown	76	78	2	2.63%		
Perry	Perryville	7,667	7,935	268	3.50%		
Pettis	**Countywide**	**39,403**	**40,121**	**718**	**1.82%**	**$25,764**	**26**
Pettis	Green Ridge	445	455	10	2.25%		
Pettis	Houstonia	275	287	12	4.36%		

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Pettis	Hughesville	174	181	7	4.02%		
Pettis	La Monte	1,064	1,062	-2	-0.19%		
Pettis	Sedalia	20,339	20,430	91	0.45%		
Pettis	Smithton	510	502	-8	-1.57%		
Pettis	Ionia*	108	115	7	6.48%		
Pettis	Windsor*	3,087	3,265	178	5.77%		
Phelps	**Countywide**	**39,825**	**42,125**	**2,300**	**5.78%**	**$25,203**	**31**
Phelps	Doolittle	644	670	26	4.04%		
Phelps	Edgar Springs	190	188	-2	-1.05%		
Phelps	Newburg	484	479	-5	-1.03%		
Phelps	Rolla	16,367	17,717	1,350	8.25%		
Phelps	St. James	3,704	4,041	337	9.10%		
Pike	**Countywide**	**18,351**	**18,762**	**411**	**2.24%**	**$21,881**	**82**
Pike	Annada	48	50	2	4.17%		
Pike	Bowling Green	3,260	5,185	1,925	59.05%		
Pike	Clarksville	490	512	22	4.49%		
Pike	Curryville	251	254	3	1.20%		
Pike	Eolia	435	455	20	4.60%		
Pike	Frankford	351	365	14	3.99%		
Pike	Louisiana	3,863	3,881	18	0.47%		
Pike	Paynesville	91	96	5	5.49%		
Platte	**Countywide**	**73,781**	**82,085**	**8,304**	**11.25%**	**$36,054**	**2**
Platte	Camden Point	484	547	63	13.02%		
Platte	Dearborn	529	531	2	0.38%		
Platte	Edgerton	533	546	13	2.44%		
Platte	Farley	226	253	27	11.95%		
Platte	Ferrelview	593	588	-5	-0.84%		
Platte	Houston Lake	284	276	-8	-2.82%		
Platte	Iatan	54	68	14	25.93%		
Platte	Lake Waukomis	917	913	-4	-0.44%		
Platte	Northmoor	399	407	8	2.01%		
Platte	Parkville	4,059	5,116	1,057	26.04%		
Platte	Platte City	3,866	4,907	1,041	26.93%		
Platte	Platte Woods	474	462	-12	-2.53%		
Platte	Ridgely	64	73	9	14.06%		
Platte	Riverside	2,979	2,964	-15	-0.50%		
Platte	Tracy	213	211	-2	-0.94%		
Platte	Weatherby Lake	1,873	1,870	-3	-0.16%		
Platte	Weston	1,631	1,644	13	0.80%		
Platte	Kansas City*	441,545	444,965	3,420	0.77%		
Polk	**Countywide**	**26,992**	**28,892**	**1,900**	**7.04%**	**$20,461**	**99**
Polk	Aldrich	75	78	3	4.00%		
Polk	Bolivar	9,143	10,179	1,036	11.33%		

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Polk	Fair Play	418	439	21	5.02%		
Polk	Flemington	124	130	6	4.84%		
Polk	Goodnight	(X)	16	16	new		
Polk	Halfway	176	185	9	5.11%		
Polk	Humansville	946	986	40	4.23%		
Polk	Morrisville	344	362	18	5.23%		
Polk	Pleasant Hope	548	575	27	4.93%		
Pulaski	**Countywide**	**41,165**	**44,187**	**3,022**	**7.34%**	**$26,879**	**20**
Pulaski	Crocker	1,033	1,010	-23	-2.23%		
Pulaski	Dixon	1,570	1,548	-22	-1.40%		
Pulaski	St. Robert	2,760	3,155	395	14.31%		
Pulaski	Waynesville	3,507	3,511	4	0.11%		
Pulaski	Richland*	1,805	1,776	-29	-1.61%		
Putnam	**Countywide**	**5,223**	**5,168**	**-55**	**-1.05%**	**$20,879**	**92**
Putnam	Livonia	114	114	0	0.00%		
Putnam	Lucerne	92	91	-1	-1.09%		
Putnam	Powersville	86	86	0	0.00%		
Putnam	Unionville	2,041	1,981	-60	-2.94%		
Putnam	Worthington	89	89	0	0.00%		
Ralls	**Countywide**	**9,626**	**9,761**	**135**	**1.40%**	**$25,111**	**32**
Ralls	Center	644	637	-7	-1.09%		
Ralls	Hannibal*	17,757	17,649	-108	-0.61%		
Ralls	Monroe City*	2,588	2,556	-32	-1.24%		
Ralls	New London	1,001	992	-9	-0.90%		
Ralls	Perry	666	657	-9	-1.35%		
Ralls	Rensselaer	145	149	4	2.76%		
Randolph	**Countywide**	**24,663**	**25,336**	**673**	**2.73%**	**$23,462**	**64**
Randolph	Cairo	293	304	11	3.75%		
Randolph	Clark	275	289	14	5.09%		
Randolph	Clifton Hill	124	129	5	4.03%		
Randolph	Higbee	623	652	29	4.65%		
Randolph	Huntsville	1,553	1,625	72	4.64%		
Randolph	Jacksonville	163	171	8	4.91%		
Randolph	Moberly	11,945	13,921	1,976	16.54%		
Randolph	Renick	221	235	14	6.33%		
Ray	**Countywide**	**23,354**	**24,101**	**747**	**3.20%**	**$26,268**	**23**
Ray	Camden	209	211	2	0.96%		
Ray	Crystal Lakes	383	426	43	11.23%		
Ray	Elmira	82	83	1	1.22%		
Ray	Fleming	122	124	2	1.64%		
Ray	Hardin	614	590	-24	-3.91%		
Ray	Henrietta	457	451	-6	-1.31%		
Ray	Homestead	181	180	-1	-0.55%		

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Ray	Orrick	889	867	-22	-2.47%		
Ray	Rayville	204	205	1	0.49%		
Ray	Richmond	6,116	6,075	-41	-0.67%		
Ray	Woods Heights	742	776	34	4.58%		
Ray	Excelsior Estates*	263	274	11	4.18%		
Ray	Excelsior Springs*	10,847	11,472	625	5.76%		
Ray	Lawson*	2,336	2,406	70	3.00%		
Reynolds	**Countywide**	**6,689**	**6,585**	**-104**	**-1.55%**	**$20,819**	**94**
Reynolds	Centerville	171	174	3	1.75%		
Reynolds	Ellington	1,045	1,013	-32	-3.06%		
Reynolds	Bunker*	427	437	10	2.34%		
Ripley	**Countywide**	**13,509**	**13,851**	**342**	**2.53%**	**$19,394**	**106**
Ripley	Doniphan	1,932	1,924	-8	-0.41%		
Ripley	Naylor	610	614	4	0.66%		
Saline	**Countywide**	**23,756**	**23,075**	**-681**	**-2.87%**	**$26,535**	**21**
Saline	Arrow Rock	79	77	-2	-2.53%		
Saline	Gilliam	229	224	-5	-2.18%		
Saline	Grand Pass	53	52	-1	-1.89%		
Saline	Malta Bend	249	243	-6	-2.41%		
Saline	Marshall	12,433	12,403	-30	-0.24%		
Saline	Miami	160	157	-3	-1.88%		
Saline	Mount Leonard	123	123	0	0.00%		
Saline	Nelson	212	209	-3	-1.42%		
Saline	Slater	2,083	1,954	-129	-6.19%		
Saline	Sweet Springs	1,628	1,551	-77	-4.73%		
Saline	Blackburn*	284	278	-6	-2.11%		
Saline	Emma*	243	239	-4	-1.65%		
Schuyler	**Countywide**	**4,170**	**4,308**	**138**	**3.31%**	**$20,373**	**101**
Schuyler	Downing	396	399	3	0.76%		
Schuyler	Glenwood	203	205	2	0.99%		
Schuyler	Lancaster	737	745	8	1.09%		
Schuyler	Queen City	638	646	8	1.25%		
Schuyler	Greentop*	427	431	4	0.94%		
Scotland	**Countywide**	**4,983**	**4,928**	**-55**	**-1.10%**	**$22,312**	**76**
Scotland	Arbela	40	40	0	0.00%		
Scotland	Granger	44	44	0	0.00%		
Scotland	Memphis	2,061	2,003	-58	-2.81%		
Scotland	Rutledge	103	103	0	0.00%		
Scotland	South Gorin	143	143	0	0.00%		
Scott	**Countywide**	**40,422**	**41,143**	**721**	**1.78%**	**$24,737**	**40**
Scott	Benton	732	729	-3	-0.41%		
Scott	Blodgett	265	273	8	3.02%		
Scott	Chaffee	3,044	3,006	-38	-1.25%		

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Scott	Commerce	110	112	2	1.82%		
Scott	Diehlstadt	163	168	5	3.07%		
Scott	Haywood City	239	249	10	4.18%		
Scott	Kelso	527	523	-4	-0.76%		
Scott	Miner*	1,056	1,268	212	20.08%		
Scott	Morley	792	815	23	2.90%		
Scott	Oran	1,264	1,259	-5	-0.40%		
Scott	Scott City	4,591	4,584	-7	-0.15%		
Scott	Vanduser	217	212	-5	-2.30%		
Scott	Sikeston*	16,992	17,180	188	1.11%		
Shannon	**Countywide**	**8,324**	**8,367**	**43**	**0.52%**	**$17,929**	**112**
Shannon	Birch Tree	634	619	-15	-2.37%		
Shannon	Eminence	548	550	2	0.36%		
Shannon	Summersville*	544	555	11	2.02%		
Shannon	Winona	1,290	1,317	27	2.09%		
Shelby	**Countywide**	**6,799**	**6,744**	**-55**	**-0.81%**	**$24,874**	**34**
Shelby	Bethel	121	121	0	0.00%		
Shelby	Clarence	915	906	-9	-0.98%		
Shelby	Hunnewell	227	232	5	2.20%		
Shelby	Leonard	66	66	0	0.00%		
Shelby	Shelbina	1,943	1,886	-57	-2.93%		
Shelby	Shelbyville	682	686	4	0.59%		
St. Charles	**Countywide**	**283,883**	**329,940**	**46,057**	**16.22%**	**$32,686**	**5**
St. Charles	Augusta	218	221	3	1.38%		
St. Charles	Cottleville	1,928	2,333	405	21.01%		
St. Charles	Dardenne Prairie	4,384	6,984	2,600	59.31%		
St. Charles	Flint Hill	379	415	36	9.50%		
St. Charles	Foristell*	331	329	-2	-0.60%		
St. Charles	Josephville	270	284	14	5.19%		
St. Charles	Lake St. Louis	10,169	13,281	3,112	30.60%		
St. Charles	New Melle	124	287	163	131.45%		
St. Charles	O'Fallon	46,169	69,694	23,525	50.95%		
St. Charles	Portage Des Sioux	351	351	0	0.00%		
St. Charles	St. Charles	60,321	62,304	1,983	3.29%		
St. Charles	St. Paul	1,634	1,690	56	3.43%		
St. Charles	St. Peters	51,381	54,209	2,828	5.50%		
St. Charles	Weldon Spring	5,270	5,361	91	1.73%		
St. Charles	Weldon Spring Heights	79	75	-4	-5.06%		
St. Charles	Wentzville	6,896	17,988	11,092	160.85%		
St. Charles	West Alton	573	732	159	27.75%		
St. Clair	**Countywide**	**9,652**	**9,686**	**34**	**0.35%**	**$20,429**	**100**
St. Clair	Appleton City	1,314	1,318	4	0.30%		

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St. Clair	Collins	176	177	1	0.57%		
St. Clair	Gerster	35	35	0	0.00%		
St. Clair	Lowry City	728	738	10	1.37%		
St. Clair	Osceola	835	818	-17	-2.04%		
St. Clair	Roscoe	112	112	0	0.00%		
St. Clair	Vista	55	55	0	0.00%		
St. Francois	**Countywide**	**55,641**	**61,661**	**6,020**	**10.82%**	**$21,953**	**81**
St. Francois	Bismarck	1,470	1,558	88	5.99%		
St. Francois	Bonne Terre	4,039	6,520	2,481	61.43%		
St. Francois	Desloge	4,802	5,143	341	7.10%		
St. Francois	Farmington	13,924	15,176	1,252	8.99%		
St. Francois	Iron Mountain Lake	693	706	13	1.88%		
St. Francois	Leadington	206	219	13	6.31%		
St. Francois	Leadwood	1,160	1,173	13	1.12%		
St. Francois	Park Hills	7,861	8,525	664	8.45%		
St. Louis	**Countywide**	**1,016,315**	**1,004,666**	**-11,649**	**-1.15%**	**$45,101**	**1**
St. Louis	Ballwin	31,283	30,481	-802	-2.56%		
St. Louis	Bella Villa	687	655	-32	-4.66%		
St. Louis	Bellefontaine Neighbors	11,271	10,616	-655	-5.81%		
St. Louis	Bellerive	254	259	5	1.97%		
St. Louis	Bel-Nor	1,598	1,526	-72	-4.51%		
St. Louis	Bel-Ridge	3,082	2,970	-112	-3.63%		
St. Louis	Berkeley	10,063	9,631	-432	-4.29%		
St. Louis	Beverly Hills	603	575	-28	-4.64%		
St. Louis	Black Jack	6,792	6,920	128	1.88%		
St. Louis	Breckenridge Hills	4,817	4,608	-209	-4.34%		
St. Louis	Brentwood	7,693	7,365	-328	-4.26%		
St. Louis	Bridgeton	15,550	15,259	-291	-1.87%		
St. Louis	Calverton Park	1,322	1,303	-19	-1.44%		
St. Louis	Champ	12	18	6	50.00%		
St. Louis	Charlack	1,431	1,380	-51	-3.56%		
St. Louis	Chesterfield	46,802	47,020	218	0.47%		
St. Louis	Clarkson Valley	2,675	2,602	-73	-2.73%		
St. Louis	Clayton	12,825	16,061	3,236	25.23%		
St. Louis	Cool Valley	1,081	1,033	-48	-4.44%		
St. Louis	Country Club Hills	1,381	1,318	-63	-4.56%		
St. Louis	Country Life Acres	81	81	0	0.00%		
St. Louis	Crestwood	11,863	11,691	-172	-1.45%		
St. Louis	Creve Coeur	16,500	16,975	475	2.88%		
St. Louis	Crystal Lake Park	457	450	-7	-1.53%		
St. Louis	Dellwood	5,255	5,027	-228	-4.34%		
St. Louis	Des Peres	8,592	8,619	27	0.31%		

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St. Louis	Edmundson	840	803	-37	-4.40%		
St. Louis	Ellisville	9,104	9,353	249	2.74%		
St. Louis	Eureka	7,676	8,957	1,281	16.69%		
St. Louis	Fenton	4,360	4,376	16	0.37%		
St. Louis	Ferguson	22,406	21,458	-948	-4.23%		
St. Louis	Flordell Hills	931	887	-44	-4.73%		
St. Louis	Florissant	50,497	51,812	1,315	2.60%		
St. Louis	Frontenac	3,483	3,517	34	0.98%		
St. Louis	Glendale	5,767	5,595	-172	-2.98%		
St. Louis	Glen Echo Park	166	162	-4	-2.41%		
St. Louis	Grantwood Village	883	888	5	0.57%		
St. Louis	Greendale	722	708	-14	-1.94%		
St. Louis	Green Park	2,666	2,657	-9	-0.34%		
St. Louis	Hanley Hills	2,124	2,079	-45	-2.12%		
St. Louis	Hazelwood	26,206	25,535	-671	-2.56%		
St. Louis	Hillsdale	1,477	1,421	-56	-3.79%		
St. Louis	Huntleigh	323	336	13	4.02%		
St. Louis	Jennings	15,469	14,926	-543	-3.51%		
St. Louis	Kinloch	449	435	-14	-3.12%		
St. Louis	Kirkwood	27,324	27,038	-286	-1.05%		
St. Louis	Ladue	8,645	8,269	-376	-4.35%		
St. Louis	Lakeshire	1,375	1,318	-57	-4.15%		
St. Louis	Mackenzie	137	134	-3	-2.19%		
St. Louis	Manchester	19,161	18,970	-191	-1.00%		
St. Louis	Maplewood	9,228	8,808	-420	-4.55%		
St. Louis	Marlborough	2,235	2,191	-44	-1.97%		
St. Louis	Maryland Heights	25,756	26,544	788	3.06%		
St. Louis	Moline Acres	2,662	2,579	-83	-3.12%		
St. Louis	Normandy	5,153	5,032	-121	-2.35%		
St. Louis	Northwoods	4,643	4,435	-208	-4.48%		
St. Louis	Norwood Court	1,061	1,042	-19	-1.79%		
St. Louis	Oakland	1,540	1,579	39	2.53%		
St. Louis	Olivette	7,438	7,455	17	0.23%		
St. Louis	Overland	16,838	16,082	-756	-4.49%		
St. Louis	Pagedale	3,616	3,486	-130	-3.60%		
St. Louis	Pasadena Hills	1,147	1,122	-25	-2.18%		
St. Louis	Pasadena Park	489	467	-22	-4.50%		
St. Louis	Pine Lawn	4,204	4,092	-112	-2.66%		
St. Louis	Richmond Heights	9,602	9,309	-293	-3.05%		
St. Louis	Riverview	3,146	2,995	-151	-4.80%		
St. Louis	Rock Hill	4,765	4,700	-65	-1.36%		
St. Louis	St. Ann	13,607	13,092	-515	-3.78%		
St. Louis	St. George	1,288	1,242	-46	-3.57%		

County	Community Name	2000 Census Population	2005 Estimated Population	Estimated Population Numerical Change 2000-2005	Estimated Population Percent Change 2000-2005	2004 Per Capita Personal Income	Rank by 2004 Per Capita Personal Income
St. Louis	St. John	6,871	6,558	-313	-4.56%		
St. Louis	Shrewsbury	6,644	6,393	-251	-3.78%		
St. Louis	Sunset Hills	8,267	8,374	107	1.29%		
St. Louis	Sycamore Hills	722	705	-17	-2.35%		
St. Louis	Town and Country	10,894	10,807	-87	-0.80%		
St. Louis	Twin Oaks	362	354	-8	-2.21%		
St. Louis	University City	37,428	37,170	-258	-0.69%		
St. Louis	Uplands Park	460	449	-11	-2.39%		
St. Louis	Valley Park	6,518	6,405	-113	-1.73%		
St. Louis	Velda City	1,616	1,542	-74	-4.58%		
St. Louis	Velda Village Hills	1,090	1,063	-27	-2.48%		
St. Louis	Vinita Park	1,924	1,837	-87	-4.52%		
St. Louis	Vinita Terrace	292	286	-6	-2.05%		
St. Louis	Warson Woods	1,983	1,906	-77	-3.88%		
St. Louis	Webster Groves	23,230	22,896	-334	-1.44%		
St. Louis	Wellston	2,460	2,370	-90	-3.66%		
St. Louis	Westwood	284	296	12	4.23%		
St. Louis	Wilbur Park	475	467	-8	-1.68%		
St. Louis	Wildwood	32,884	34,831	1,947	5.92%		
St. Louis	Winchester	1,651	1,585	-66	-4.00%		
St. Louis	Woodson Terrace	4,189	4,111	-78	-1.86%		
St. Louis	Pacific*	5,482	7,098	1,616	29.48%		
Ste. Genevieve	**Countywide**	**17,842**	**18,198**	**356**	**2.00%**	**$23,813**	**58**
Ste. Genevieve	Bloomsdale	419	434	15	3.58%		
Ste. Genevieve	Ste. Genevieve	4,476	4,454	-22	-0.49%		
Ste. Genevieve	St. Mary	377	388	11	2.92%		
Stoddard	**Countywide**	**29,705**	**29,714**	**9**	**0.03%**	**$23,973**	**55**
Stoddard	Advance	1,244	1,216	-28	-2.25%		
Stoddard	Bell City	461	453	-8	-1.74%		
Stoddard	Bernie	1,777	1,801	24	1.35%		
Stoddard	Bloomfield	1,952	1,888	-64	-3.28%		
Stoddard	Dexter	7,356	7,596	240	3.26%		
Stoddard	Dudley	289	293	4	1.38%		
Stoddard	Essex	524	530	6	1.15%		
Stoddard	Penermon	75	76	1	1.33%		
Stoddard	Puxico	1,145	1,150	5	0.44%		
Stone	**Countywide**	**28,658**	**30,931**	**2,273**	**7.93%**	**$24,222**	**48**
Stone	Blue Eye	129	97	-32	-24.81%		
Stone	Branson West	408	485	77	18.87%		
Stone	Coney Island	94	101	7	7.45%		
Stone	Crane	1,390	1,442	52	3.74%		
Stone	Galena	451	528	77	17.07%		
Stone	Hurley	157	160	3	1.91%		

County	Community Name	2000 Census Population	2005 Estimated Population	Estimated Population Numerical Change 2000-2005	Estimated Population Percent Change 2000-2005	2004 Per Capita Personal Income	Rank by 2004 Per Capita Personal Income
Stone	Indian Point	588	614	26	4.42%		
Stone	Kimberling City	2,253	2,520	267	11.85%		
Stone	McCord Bend	292	316	24	8.22%		
Stone	Reeds Spring	465	672	207	44.52%		
Sullivan	**Countywide**	**7,219**	**6,907**	**-312**	**-4.32%**	**$24,473**	**45**
Sullivan	Greencastle	308	299	-9	-2.92%		
Sullivan	Green City	688	650	-38	-5.52%		
Sullivan	Harris	105	101	-4	-3.81%		
Sullivan	Humphreys	164	158	-6	-3.66%		
Sullivan	Milan	1,958	1,849	-109	-5.57%		
Sullivan	Newtown	209	197	-12	-5.74%		
Sullivan	Osgood	51	49	-2	-3.92%		
Sullivan	Pollock	131	126	-5	-3.82%		
Taney	**Countywide**	**39,703**	**42,985**	**3,282**	**8.27%**	**$24,021**	**53**
Taney	Bradleyville	(X)	84	84	new		
Taney	Branson	6,050	7,010	960	15.87%		
Taney	Bull Creek	225	230	5	2.22%		
Taney	Forsyth	1,686	1,706	20	1.19%		
Taney	Hollister	3,867	3,835	-32	-0.83%		
Taney	Kirbyville	(X)	143	143	new		
Taney	Merriam Woods	1,142	1,133	-9	-0.79%		
Taney	Rockaway Beach	577	588	11	1.91%		
Taney	Taneyville	359	384	25	6.96%		
Texas	**Countywide**	**23,003**	**24,614**	**1,611**	**7.00%**	**$17,779**	**114**
Texas	Cabool	2,168	2,140	-28	-1.29%		
Texas	Houston	1,992	2,005	13	0.65%		
Texas	Licking	1,471	1,500	29	1.97%		
Texas	Plato	(X)	65	65	new		
Texas	Raymondville	442	439	-3	-0.68%		
Texas	Mountain Grove*	4,574	4,594	20	0.44%		
Texas	Summersville*	544	555	11	2.02%		
Vernon	**Countywide**	**20,454**	**20,441**	**-13**	**-0.06%**	**$24,051**	**52**
Vernon	Bronaugh	245	248	3	1.22%		
Vernon	Deerfield	75	76	1	1.33%		
Vernon	Harwood	90	91	1	1.11%		
Vernon	Metz	67	67	0	0.00%		
Vernon	Milo	84	84	0	0.00%		
Vernon	Moundville	103	104	1	0.97%		
Vernon	Nevada	8,607	8,457	-150	-1.74%		
Vernon	Richards	95	96	1	1.05%		
Vernon	Schell City	286	290	4	1.40%		
Vernon	Sheldon	529	534	5	0.95%		
Vernon	Stotesbury	43	43	0	0.00%		

County	Community Name	2000 Census Population	2005 Estimated Population	Estimated Population Numerical Change 2000-2005	Estimated Population Percent Change 2000-2005	2004 Per Capita Personal Income	Rank by 2004 Per Capita Personal Income
Vernon	Walker	275	279	4	1.45%		
Warren	**Countywide**	**24,525**	**28,764**	**4,239**	**17.28%**	**$26,077**	**24**
Warren	Innsbrook	469	536	67	14.29%		
Warren	Marthasville	837	864	27	3.23%		
Warren	Pendleton	(X)	53	53	new		
Warren	Truesdale	397	489	92	23.17%		
Warren	Warrenton	5,281	6,612	1,331	25.20%		
Warren	Wright City	1,532	2,440	908	59.27%		
Warren	Foristell*	331	329	-2	-0.60%		
Washington	**Countywide**	**23,344**	**24,032**	**688**	**2.95%**	**$18,854**	**108**
Washington	Caledonia	158	163	5	3.16%		
Washington	Irondale	437	445	8	1.83%		
Washington	Mineral Point	363	377	14	3.86%		
Washington	Potosi	2,662	2,709	47	1.77%		
Wayne	**Countywide**	**13,259**	**13,097**	**-162**	**-1.22%**	**$19,857**	**104**
Wayne	Greenville	451	446	-5	-1.11%		
Wayne	Mill Spring	219	216	-3	-1.37%		
Wayne	Piedmont	1,992	1,975	-17	-0.85%		
Wayne	Williamsville	379	373	-6	-1.58%		
Webster	**Countywide**	**31,045**	**34,745**	**3,700**	**11.92%**	**$19,715**	**105**
Webster	Diggins	298	334	36	12.08%		
Webster	Fordland	684	746	62	9.06%		
Webster	Marshfield	5,720	6,763	1,043	18.23%		
Webster	Niangua	445	484	39	8.76%		
Webster	Rogersville*	1,508	2,239	731	48.47%		
Webster	Seymour	1,834	1,960	126	6.87%		
Worth	**Countywide**	**2,382**	**2,174**	**-208**	**-8.73%**	**$21,388**	**87**
Worth	Allendale	54	50	-4	-7.41%		
Worth	Denver	40	37	-3	-7.50%		
Worth	Grant City	926	826	-100	-10.80%		
Worth	Irena	33	31	-2	-6.06%		
Worth	Sheridan	185	172	-13	-7.03%		
Worth	Worth	94	87	-7	-7.45%		
Wright	**Countywide**	**17,955**	**18,306**	**351**	**1.95%**	**$18,207**	**111**
Wright	Hartville	607	603	-4	-0.66%		
Wright	Mansfield	1,349	1,352	3	0.22%		
Wright	Mountain Grove*	4,574	4,594	20	0.44%		
Wright	Norwood	552	576	24	4.35%		
St. Louis City	**St. Louis**	**348,189**	**344,362**	**-3,827**	**-1.10%**	**$26,908**	**19**

Sources: U.S. Census Bureau, 2006; Bureau of Economic Analysis, 2006
Note:
* Jurisdiction is reported in multiple counties

Appendix C: HAZUS-MH Flood Results by County

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income loss	Total Direct and Income Loss	HAZUS Loss Ratio	Calc Loss Ratio	# Bldgs Risk	# Substan-tially Damaged	Disp. People	Shelter Needs
Adair*	$1,471,000	$1,094,000	$4,000	$2,569,000	$1,025,000	$3,594,000	1.2%	0.12%	2	0	131	4
Andrew	$7,623,000	$5,126,000	$40,000	$12,789,000	$3,087,000	$15,876,000	5.8%	0.88%	54	0	318	65
Atchison	$4,110,000	$3,038,000	$19,000	$7,167,000	$3,278,000	$10,445,000	6.8%	1.26%	42	4	326	88
Audrain	$5,370,000	$5,318,000	$110,000	$10,798,000	$9,406,000	$20,204,000	2.4%	0.39%	42	0	488	227
Barry*	$6,601,000	$12,337,000	$359,000	$19,297,000	$19,660,000	$38,957,000	3.4%	0.44%	20	0	442	106
Barton*	$2,942,000	$4,423,000	$169,000	$7,534,000	$5,688,000	$13,222,000	4.6%	0.54%	15	0	287	145
Bates	$3,253,000	$3,623,000	$59,000	$6,935,000	$3,646,000	$10,581,000	3.7%	0.44%	7	0	259	15
Benton*	$5,936,000	$9,810,000	$293,000	$16,039,000	$27,205,000	$43,244,000	3.7%	0.61%	13	0	167	24
Bollinger	$5,590,000	$6,588,000	$191,000	$12,369,000	$7,476,000	$19,845,000	3.3%	1.12%	40	3	508	183
Boone	$41,861,000	$58,824,000	$808,000	$101,493,000	$81,800,000	$183,293,000	4.4%	0.53%	181	1	1,379	752
Buchanan	$25,459,000	$32,773,000	$1,716,000	$59,948,000	$34,625,000	$94,573,000	8.4%	0.49%	213	12	1,339	661
Butler	$20,578,000	$35,244,000	$1,674,000	$57,496,000	$56,500,000	$113,996,000	6.8%	1.09%	285	116	3,607	2,449
Caldwell*	$535,000	$245,000		$780,000	$1,000	$781,000	1.1%	0.14%	0	0	62	1
Callaway	$8,768,000	$5,387,000	$29,000	$14,184,000	$2,153,000	$16,337,000	1.9%	0.47%	34	2	549	121
Camden	$2,795,000	$2,020,000	$49,000	$4,864,000	$1,043,000	$5,907,000	2.3%	0.08%	9	0	124	6
Cape Girardeau	$16,259,000	$24,488,000	$954,000	$41,701,000	$32,283,000	$73,984,000	3.3%	0.40%	71	0	827	332
Carroll*	$3,701,000	$2,111,000	$23,000	$5,835,000	$370,000	$6,205,000	5.2%	0.67%	18	0	234	14
Carter	$8,528,000	$9,006,000	$195,000	$17,729,000	$18,260,000	$35,989,000	7.8%	3.16%	41	4	203	56
Cass	$9,899,000	$6,892,000	$73,000	$16,864,000	$4,377,000	$21,241,000	2.2%	0.21%	46	0	596	75
Cedar	$1,390,000	$826,000		$2,216,000	$411,000	$2,627,000	2.4%	0.22%	3	0	115	5
Chariton	$4,452,000	$2,268,000		$6,720,000	$118,000	$6,838,000	3.9%	0.96%	35	0	289	12
Christian	$7,817,000	$6,212,000	$65,000	$14,094,000	$1,025,000	$15,119,000	2.8%	0.32%	17	0	375	115
Clark	$3,740,000	$2,423,000	$23,000	$6,186,000	$1,350,000	$7,536,000	4.7%	1.13%	21	11	373	56
Clay	$399,290,000	$593,948,000	$38,013,000	$1,031,251,000	$541,997,000	$1,573,248,000	31.9%	3.13%	1,208	367	6,073	5,062
Clinton	$2,204,000	$1,947,000	$24,000	$4,175,000	$721,000	$4,896,000	2.0%	0.20%	8	0	93	9
Cole	$35,015,000	$36,467,000	$520,000	$72,002,000	$483,689,000	$555,691,000	6.2%	0.81%	230	4	727	253
Cooper	$4,710,000	$5,304,000	$76,000	$10,090,000	$7,733,000	$17,823,000	3.8%	0.59%	16	1	243	16
Crawford	$17,683,000	$23,184,000	$736,000	$41,603,000	$58,339,000	$99,942,000	7.1%	1.58%	66	0	441	102
Dade*	$651,000	$315,000		$966,000		$966,000	1.3%	0.19%	0	0	64	0
Dallas	$2,660,000	$1,399,000	$2,000	$4,061,000	$65,000	$4,126,000	2.1%	0.44%	0	0	170	9
Daviess	$2,669,000	$4,756,000	$88,000	$7,513,000	$7,918,000	$15,431,000	4.6%	0.67%	3	0	95	5
DeKalb	$1,303,000	$1,313,000	$41,000	$2,657,000	$1,080,000	$3,737,000	3.1%	0.31%	2	0	121	7

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income loss	Total Direct and Income Loss	HAZUS Loss Ratio	Calc Loss Ratio	# Bldgs Risk	# Substan-tially Damaged	Disp. People	Shelter Needs
Dent	$3,727,000	$3,592,000	$147,000	$7,466,000	$2,403,000	$9,869,000	2.0%	0.54%	13	1	235	27
Douglas	$1,651,000	$853,000	$4,000	$2,508,000	$44,000	$2,552,000	1.4%	0.35%	3	0	95	1
Dunklin	$1,847,000	$2,909,000	$48,000	$4,804,000	$1,297,000	$6,101,000	1.8%	0.15%	10	1	773	292
Franklin	$53,617,000	$43,905,000	$1,920,000	$99,442,000	$26,469,000	$125,911,000	4.7%	1.03%	332	1	1,633	557
Gasconade	$10,175,000	$7,243,000	$171,000	$17,589,000	$2,365,000	$19,954,000	5.0%	1.21%	90	6	473	99
Gentry	$1,307,000	$1,126,000	$10,000	$2,443,000	$112,000	$2,555,000	3.5%	0.37%	4	0	87	4
Greene*	$15,691,000	$16,568,000	$210,000	$32,469,000	$10,769,000	$43,238,000	2.4%	0.11%	32	0	897	340
Grundy	$1,965,000	$1,689,000	$15,000	$3,669,000	$1,900,000	$5,569,000	3.1%	0.38%	14	0	155	14
Harrison	$3,201,000	$2,062,000	$37,000	$5,300,000	$690,000	$5,990,000	3.5%	0.72%	16	0	226	22
Henry	$1,495,000	$912,000	$11,000	$2,418,000	$263,000	$2,681,000	2.1%	0.13%	3	0	150	4
Hickory	$1,338,000	$906,000	$5,000	$2,249,000	$508,000	$2,757,000	1.9%	0.31%	10	0	79	31
Holt	$11,916,000	$9,032,000	$114,000	$21,062,000	$36,057,000	$57,119,000	16.3%	4.34%	200	59	463	154
Howard	$4,994,000	$3,888,000	$175,000	$9,057,000	$1,983,000	$11,040,000	5.0%	1.14%	54	1	437	200
Howell	$3,445,000	$5,595,000	$292,000	$9,332,000	$9,404,000	$18,736,000	2.9%	0.23%	13	0	291	34
Iron	$2,901,000	$2,404,000	$22,000	$5,327,000	$2,242,000	$7,569,000	2.2%	0.64%	34	0	367	117
Jackson	$416,396,000	$639,720,000	$41,524,000	$1,097,640,000	$708,470,000	$1,806,110,000	16.8%	0.92%	1,397	99	6,444	5,005
Jasper	$19,169,000	$19,942,000	$802,000	$39,913,000	$12,884,000	$52,797,000	4.3%	0.36%	194	1	1,792	841
Jefferson	$95,162,000	$69,632,000	$1,522,000	$166,316,000	$38,434,000	$204,750,000	4.3%	0.89%	858	13	4,827	3,203
Johnson*	$6,961,000	$9,247,000	$260,000	$16,468,000	$9,157,000	$25,625,000	3.3%	0.25%	22	0	266	16
Knox	$1,186,000	$1,332,000	$19,000	$2,537,000	$1,784,000	$4,321,000	2.4%	0.52%	4	0	107	22
Laclede	$3,585,000	$3,084,000	$46,000	$6,715,000	$2,928,000	$9,643,000	2.6%	0.24%	2	0	217	13
Lafayette	$3,566,000	$1,907,000	$5,000	$5,478,000	$378,000	$5,856,000	1.6%	0.19%	15	0	198	7
Lawrence	$4,326,000	$6,202,000	$279,000	$10,807,000	$12,450,000	$23,257,000	3.6%	0.29%	26	1	481	83
Lewis	$4,055,000	$6,384,000	$273,000	$10,712,000	$8,172,000	$18,884,000	5.1%	0.96%	15	1	426	121
Lincoln	$27,744,000	$17,778,000	$288,000	$45,810,000	$7,479,000	$53,289,000	5.2%	1.55%	276	36	1,454	478
Linn	$2,257,000	$4,789,000	$143,000	$7,189,000	$8,121,000	$15,310,000	6.1%	0.35%	6	0	207	43
Livingston	$1,855,000	$2,545,000	$54,000	$4,454,000	$3,698,000	$8,152,000	5.2%	0.26%	14	0	133	9
Macon	$1,661,000	$1,514,000	$35,000	$3,210,000	$1,106,000	$4,316,000	2.2%	0.23%	4	0	193	7
Madison	$7,962,000	$10,655,000	$572,000	$19,189,000	$14,047,000	$33,236,000	4.9%	1.44%	39	0	430	144
Maries	$2,295,000	$1,415,000	$20,000	$3,730,000	$1,174,000	$4,904,000	1.6%	0.59%	5	0	88	1
Marion	$12,680,000	$17,231,000	$1,019,000	$30,930,000	$14,820,000	$45,750,000	5.1%	0.81%	86	4	670	214
McDonald	$20,105,000	$23,819,000	$1,273,000	$45,197,000	$24,383,000	$69,580,000	8.3%	2.76%	197	2	1,258	519
Mercer	$958,000	$1,214,000	$69,000	$2,241,000	$977,000	$3,218,000	2.9%	0.49%	0	0	53	0
Miller	$2,820,000	$1,434,000	$1,000	$4,255,000	$22,000	$4,277,000	1.7%	0.26%	30	0	103	3
Mississippi	$3,283,000	$2,608,000	$13,000	$5,904,000	$3,122,000	$9,026,000	5.6%	0.58%	22	0	416	120
Moniteau	$2,018,000	$979,000		$2,997,000		$2,997,000	2.2%	0.30%	5	0	149	4
Monroe	$3,016,000	$2,441,000	$45,000	$5,502,000	$1,340,000	$6,842,000	3.1%	0.75%	3	0	179	6

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income loss	Total Direct and Income Loss	HAZUS Loss Ratio	Calc Loss Ratio	# Bldgs Risk	# Substan-tially Damaged	Disp. People	Shelter Needs
Montgomery	$2,910,000	$1,436,000		$4,346,000		$4,346,000	2.2%	0.43%	14	0	153	8
Morgan	$9,337,000	$5,370,000	$63,000	$14,770,000	$1,158,000	$15,928,000	1.9%	0.73%	204	42	272	24
New Madrid	$13,771,000	$12,859,000	$176,000	$26,806,000	$17,875,000	$44,681,000	6.4%	1.62%	295	191	2,895	1,656
Newton	$8,617,000	$9,214,000	$300,000	$18,131,000	$11,267,000	$29,398,000	3.6%	0.37%	120	0	1,107	481
Nodaway	$1,967,000	$1,668,000	$8,000	$3,643,000	$2,310,000	$5,953,000	2.4%	0.18%	3	0	174	3
Oregon	$7,059,000	$11,206,000	$626,000	$18,891,000	$12,391,000	$31,282,000	9.6%	1.79%	22	0	181	74
Osage	$12,676,000	$8,447,000	$301,000	$21,424,000	$2,234,000	$23,658,000	5.6%	1.61%	114	9	411	82
Ozark	$5,632,000	$8,347,000	$818,000	$14,797,000	$7,957,000	$22,754,000	4.1%	1.41%	11	0	130	5
Pemiscot	$149,637,000	$175,951,000	$3,451,000	$329,039,000	$327,493,000	$656,532,000	32.8%	18.53%	2,028	1,029	10,606	8,769
Perry	$4,639,000	$3,540,000	$58,000	$8,237,000	$1,728,000	$9,965,000	2.8%	0.43%	15	2	224	20
Pettis	$5,805,000	$6,304,000	$333,000	$12,442,000	$3,032,000	$15,474,000	2.9%	0.27%	14	1	436	102
Phelps	$5,494,000	$3,401,000	$72,000	$8,967,000	$1,057,000	$10,024,000	2.6%	0.29%	36	7	273	74
Pike	$4,714,000	$3,379,000	$104,000	$8,197,000	$5,604,000	$13,801,000	3.5%	0.55%	61	9	267	50
Platte	$68,425,000	$97,825,000	$6,833,000	$173,083,000	$59,711,000	$232,794,000	10.9%	1.39%	214	9	1,087	469
Polk	$3,365,000	$2,422,000	$54,000	$5,841,000	$1,698,000	$7,539,000	2.0%	0.29%	3	0	232	12
Pulaski	$10,699,000	$8,897,000	$111,000	$19,707,000	$8,286,000	$27,993,000	3.5%	0.52%	51	0	422	156
Putnam	$857,000	$761,000	$8,000	$1,626,000	$664,000	$2,290,000	2.0%	0.36%	2	0	91	2
Ralls	$3,170,000	$2,589,000	$65,000	$5,824,000	$1,460,000	$7,284,000	2.4%	0.67%	22	4	289	126
Randolph	$1,429,000	$1,334,000	$54,000	$2,817,000	$2,066,000	$4,883,000	1.5%	0.11%	1	0	132	1
Ray	$9,644,000	$6,549,000	$175,000	$16,368,000	$3,723,000	$20,091,000	4.2%	0.78%	82	1	1,302	647
Reynolds	$8,330,000	$4,746,000	$6,000	$13,082,000	$737,000	$13,819,000	4.3%	2.44%	117	2	571	204
Ripley	$13,938,000	$20,662,000	$3,564,000	$38,164,000	$9,279,000	$47,443,000	11.2%	2.75%	70	2	445	150
Saline*	$8,804,000	$10,807,000	$230,000	$19,841,000	$17,339,000	$37,180,000	5.6%	0.69%	46	0	388	132
Schuyler	$427,000	$258,000		$685,000	$364,000	$1,049,000	1.0%	0.23%	0	0	60	0
Scotland	$1,289,000	$2,421,000	$88,000	$3,798,000	$3,830,000	$7,628,000	4.3%	0.55%	0	0	112	6
Scott	$4,333,000	$5,246,000	$363,000	$9,942,000	$7,415,000	$17,357,000	1.7%	0.22%	30	2	1,240	627
Shannon	$2,425,000	$2,099,000	$76,000	$4,600,000	$1,366,000	$5,966,000	2.7%	0.80%	8	0	108	14
Shelby	$1,178,000	$1,722,000	$19,000	$2,919,000	$2,967,000	$5,886,000	3.3%	0.35%	4	0	89	1
St. Charles	$107,966,000	$104,099,000	$3,833,000	$215,898,000	$87,979,000	$303,877,000	5.7%	0.61%	918	112	3,443	1,827
St. Clair	$4,810,000	$2,675,000	$8,000	$7,493,000	$1,001,000	$8,494,000	2.9%	1.11%	18	0	161	17
St. Francois	$15,513,000	$12,392,000	$124,000	$28,029,000	$13,853,000	$41,882,000	4.2%	0.56%	64	0	691	163
St. Louis	$606,219,000	$919,268,000	$66,943,000	$1,592,430,000	$849,988,000	$2,442,418,000	11.9%	0.81%	1,852	47	9,960	8,490
St. Louis City	$45,481,000	$54,041,000	$2,268,000	$101,790,000	$71,506,000	$173,296,000	4.8%	0.20%	388	10	2,825	2,520
Ste. Genevieve	$6,681,000	$7,785,000	$445,000	$14,911,000	$6,112,000	$21,023,000	2.0%	0.65%	26	0	367	77
Stoddard	$1,940,000	$1,686,000	$39,000	$3,665,000	$5,156,000	$8,821,000	1.7%	0.15%	14	0	510	53
Stone	$20,766,000	$13,482,000	$123,000	$34,371,000	$11,169,000	$45,540,000	3.2%	1.40%	183	0	713	196
Sullivan*	$1,282,000	$1,209,000	$19,000	$2,510,000	$1,073,000	$3,583,000	1.7%	0.40%	1	0	178	10

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income loss	Total Direct and Income Loss	HAZUS Loss Ratio	Calc Loss Ratio	# Bldgs Risk	# Substan-tially Damaged	Disp. People	Shelter Needs
Taney*	$14,663,000	$14,815,000	$316,000	$29,794,000	$17,326,000	$47,120,000	2.3%	0.67%	119	6	770	368
Texas	$3,071,000	$2,944,000	$383,000	$6,398,000	$1,325,000	$7,723,000	1.9%	0.30%	1	0	118	2
Vernon	$5,947,000	$4,066,000	$11,000	$10,024,000	$1,375,000	$11,399,000	4.7%	0.59%	40	0	483	185
Warren	$6,696,000	$6,811,000	$283,000	$13,790,000	$5,284,000	$19,074,000	3.0%	0.49%	17	1	218	14
Washington	$2,523,000	$1,806,000	$38,000	$4,367,000	$907,000	$5,274,000	1.9%	0.31%	10	0	213	13
Wayne	$13,551,000	$23,226,000	$1,447,000	$38,224,000	$30,991,000	$69,215,000	6.4%	2.20%	79	3	866	361
Webster*	$1,764,000	$941,000	$3,000	$2,708,000	$53,000	$2,761,000	1.2%	0.13%	0	0	159	5
Worth	$668,000	$468,000	$3,000	$1,139,000	$278,000	$1,417,000	3.8%	0.55%	2	0	45	0
Wright	$1,765,000	$1,183,000	$14,000	$2,962,000	$641,000	$3,603,000	1.6%	0.24%	5	0	118	3

Source: HAZUS-MH MR2

Note:

* 10-meter resolution DEMs were used as a substitute for problem areas in the corresponding 30-meter DEMs

Appendix D: Past Mitigation Projects

Flood Buyouts

Community Name	County	Properties Acquired	Description of Funding Source
City of Alexandria	Clark	43	Disaster 995 FEMA and CDBG
City of Arnold	Jefferson	72	Disaster 995 FEMA and CDBG [FEMA-31; FEMA/City-1; CDBG-40]
City of Bellefontaine Neighbors	St. Louis	20	Disaster 995 FEMA and CDBG [FEMA-10; CDBG-10]
Boone County	Boone	7	Disaster 995 FEMA; Matched with other project
Buchanan County	Buchanan	36	Disaster 995 FEMA and CDBG [FEMA-17; CDBG-19]
City of Byrnes Mills	Jefferson	1	Disaster 995 FEMA and CDBG
City of Canton	Lewis	2	Disaster 995 FEMA and CDBG [FEMA/CDBG-1; CDBG-1]
Charrette Apartments (property now owned by City of Marthasville)	Warren	1	Disaster 995 FEMA and CDBG
Clark County	Clark	7	Disaster 995 FEMA and CDBG
City of Crystal City	Jefferson	18	Disaster 995 FEMA and CDBG [FEMA-12; CDBG-6]
City of Edgerton	Platte	1	Disaster 995 FEMA and CDBG
City of Excelsior Springs	Clay	49	Disaster 995 FEMA and CDB; Funded by two sources all 1993 buyout [FEMA-12; CDBG-15; City-10; Combination-12]
City of Fenton	St. Louis	9	Disaster 995 FEMA and CDBG [FEMA-3; CDBG-5; FEMA/City-1]
City of Festus	Jefferson	22	Disaster 995 FEMA and CDBG
Franklin County	Franklin	5	Disaster 995 FEMA and CDBG [FEMA-2; CDBG-2; Combination-1]
City of Hannibal	Marion	116	Disaster 995 FEMA and CDBG [FEMA-68; CDBG-39; Donated-9]
City of Hartsburg	Boone	3	Disaster 995 FEMA; Matched with other project
City of Hermann	Gasconade	22	Disaster 995 FEMA; Matched with other project
Howard County	Howard	65	Disaster 995 FEMA and CDBG [FEMA-13; CDBG-19; Combination-3]
City of Jefferson City	Cole	162	Disaster 995 FEMA and CDBG [FEMA-94; CDBG-34; Combination-34]
Jefferson County	Jefferson	131	Disaster 955 FEMA and CDBG [FEMA-58; CDBG-71; Combination-2]

Community Name	County	Properties Acquired	Description of Funding Source
City of LaGrange	Lewis	5	Disaster 995 FEMA and CDBG [FEMA-4; CDBG-1]
City of Levasy	Jackson	5	Disaster 995 FEMA and CDBG [FEMA-2; CDBG-1; Combination-2]
Lincoln County	Lincoln	265	Disaster 995 FEMA and CDBG [FEMA-153; CDBG-96; Combination-16]
Lincoln County	Lincoln	71	Disaster 867 FEMA and CDBG [FEMA-46; CDBG-15; Combination-16]
Marion County	Marion	38	Disaster 995 FEMA and CDBG [FEMA-23; CDBG-12; Combination-3]
City of Maryville	Nodaway	1	Disaster 995 FEMA and CDBG
City of Neosho	Newton	52	Disaster 995 FEMA and CDBG [FEMA-24; Combination-28]
City of Pattonsburg	Daviess	235	Disaster 995 FEMA and CDBG [FEMA-218; CDBG-10; Combination-7]
Perry County	Perry	32	Disaster 995 FEMA and CDBG [FEMA-15; CDBG-17]
City of Piedmont	Wayne	56	FMA 1996/97/98 and Disasters 995, 1006, 1023, 1054
Phelps County	Phelps	12	Disaster 995 FEMA and CDBG [FEMA-6; CDBG-6]
City of Rhineland	Gasconade	33	Disaster 995 FEMA and CDBG
City of St. Charles	St. Charles	9	Disaster 995 FEMA and CDBG [FEMA-3; CDBG-5; Combination-1]
St. Charles County	St. Charles	1159	Disaster 995 FEMA and CDBG [FEMA-817; CDBG-340; Combination-2]
City of St. Clair	Franklin	2	Disaster 995 FEMA and CDBG
City of Ste. Genevieve	Ste. Genevieve	44	Disaster 995 FEMA and CDBG [FEMA-27; CDBG-17]
St. Louis County to include cities of St. Louis, Valley Park, and Brentwood	St. Louis	438	Disaster 995 FEMA and CDBG [FEMA 313; CDBG-125]
City of St. Mary	Ste. Genevieve	36	Disaster 995 FEMA and CDBG [FEMA-23; CDBG-11; Combination-2]
City of Tracy	Platte	17	Disaster 995 FEMA and CDBG [FEMA-4; CDBG-12; Combination-1]
City of Wakenda (now disincorporated Carroll County)	Carroll	58	Disaster 995 FEMA and CDBG [FEMA-32; CDBG-16; Combination-10]
Warren County	Warren	13	Disaster 995 FEMA and CDBG [FEMA-5; CDBG-7; Combination-1]
City of Washington	Franklin	16	Disaster 995 FEMA and CDBG [FEMA-13; CDBG-3]
City of Winfield	Lincoln	37	Disaster 995 FEMA and CDBG [FEMA-8; CDBG-27; Combination-2]

Community Name	County	Properties Acquired	Description of Funding Source
City of Arnold	Jefferson	10	FMA-FEMA and State GR
Jefferson County	Jefferson	7	1998/2000 FMA-FEMA and State GR
City of Fredericktown	Madison	18	Disaster 1006 FEMA and CDBG
City of Waynesville	Pulaski	18	Disaster 1006 FEMA and CDBG [FEMA-7; CDBG-8; Combination-3]
City of Willow Springs	Howell	2	Disaster 1006 FEMA and CDBG
City of Brentwood	St. Louis	3	Disaster 1023 FEMA and CDBG; City provided the match think these flooded in 1993—not funded until later
City of Excelsior Springs	Clay	11	Disaster 1023 FEMA and CDBG; City provided the match think these flooded in 1993—not funded until later
Franklin County	Franklin	4	Disaster 1023 FEMA and CDBG
City of Cape Girardeau	Cape Girardeau	109	Disaster 1054 FEMA, CDBG; and State GR
Village of Commerce	Scott	31	Disaster 1054 FEMA and State GR
City of Portage des Sioux	St. Charles	8	Disaster 1054 FEMA and State GR
City of Avondale	Clay	5	Disaster 1253 FEMA and State GR
City of Carrollton	Carroll	6	Disaster 1253 FEMA and State GR
Franklin County	Franklin	13	Disaster 1253 FEMA and State GR
City of Independence	Jackson	12	Disaster 1253 FEMA; City provided match
City of Richmond	Ray	3	Disaster 1253 FEMA and CDBG
Franklin County	Franklin	2	Disaster 1256 FEMA and State GR
Madison County	Madison	7	Disaster 1270 and Unmet Needs 1270 FEMA and State GR
City of Annapolis	Iron	6	Unmet Needs; FEMA; and State GR
City of Liberty	Clay	7	Unmet Needs 1253 FEMA; City is providing match
City of Fredericktown	Madison	36	Disaster 1253 and 1256 and Unmet Needs 1270 FEMA and State GR
Greene County	Greene	5	Disaster 1253, 1256, and 1328 FEMA and State GR
City of Marquand	Madison	12	Disaster 1253 and 1270 and Unmet Needs 1270 FEMA and State GR
City of Fenton	St. Louis	1	Unmet Needs 1256 FEMA City provided match
City of Independence	Jackson	23	Unmet Needs 1256 FEMA
City of Northwoods	St. Louis	1	Unmet Needs 1256 FEMA; City is providing match
City of Union	Franklin	17	Disaster 1328 FEMA and State GR
City of Annapolis	Iron	7	Disaster 1403 FEMA and State GR
City of Cape Girardeau	Cape Girardeau	2	Disaster 1403 FEMA and State GR
City of Ellington	Reynolds	23	Disaster 1403 FEMA and State GR

Community Name	County	Properties Acquired	Description of Funding Source
City of Fredericktown	Madison	20	Disaster 1403 FEMA and Local
Marble Hill	Bollinger	24	Disaster 1403 FEMA and State GR
Madison County	Madison	8	Disaster 1403 FEMA and State GR
Metropolitan Sewer District	St. Louis	1	Disaster 1403 FEMA and State GR
City of Neosho	Newton	5	Disaster 1403 FEMA and State GR
City of Park Hills	St. Francois	6	Disaster 1403 FEMA and State GR
City of Piedmont	Wayne	12	Disaster 1403 FEMA and State GR
City of Poplar Bluff	Butler	36	Disaster 1403 FEMA and State GR
City of West Plains	Howell	6	Disaster 1403 FEMA and State GR
City of Arcadia	Iron	3	Disaster 1412 FEMA and State GR
City of Bull Creek	Taney	7	Disaster 1412 FEMA and State GR
City of Ellington	Reynolds	22	Disaster 1412 FEMA and State GR
Greene County	Greene	6	Disaster 1412 FEMA and Local
City of Jefferson City	Cole	1	Disaster 1412 FEMA and Local
City of Neosho	Newton	1	Disaster 1412 FEMA and Local
City of Washington	Franklin	11	Disaster 1412 FEMA and Local
City of West Plains	Howell	3	Disaster 1412 FEMA and Local
City of Arnold	Jefferson	3	Disaster 1463 FEMA and Local
City of Freeman	Cass	4	Disaster 1463 FEMA and State GR
City of Lake Annette	Cass	23	Disaster 1463 FEMA and State GR
University City	St. Louis	2	FMA 2004
Greene County	Greene	1	FMA 2006
Poplar Bluff	Butler	3	FMA 2006
Brentwood	St. Louis	1	PDMC 2005
City of Houston	Texas	1	PDMC 2005
Total Flood Buyouts		**4,045**	

Other Mitigation Projects

Community Name	County	Project Type	Description of Funding Source
Kansas City	Jackson	Rechannelization	1253 & 1256 Unmet Needs
Kansas City	Jackson	Prospect Bridge	1253 & 1256 Unmet Needs
Kansas City Habitat for Humanity	Jackson	Safe Room	Disaster 1403
City of Independence	Jackson	Bury Lines	Disaster 1403
City of Independence	Jackson	Bury Lines	Disaster 1412
City of Independence	Jackson	Bury Lines	Disaster 1412
City of Houston	Texas	Safe Room	Disaster 1412

Community Name	County	Project Type	Description of Funding Source
Rich Hill School District	Platte	Safehaven	Disaster 1412
City of Cape Girardeau	Cape Girardeau	Water Connect	Disaster 1463
Pierce City	Lawrence	Safe Room	PDMC 2002
State of Missouri		State HAZMIT Plan	PDMC 2002
Knox, Schuyler, and Scotland Counties	Knox, Schuyler, Scotland	Local Plans	PDMC 2002
MCC in Kansas City	Jackson	DRU Plan	PDMC DRU 2003
Various		Local Plans	PDMC 2003
Jefferson County	Jefferson	Elevation	FMA 2005
Boone County	Boone	Bank Stabilization	PDMC 2005
Boone County	Boone	Bank Stabilization	PDMC 2005
Clay County	Clay	Safe Room	PDMC 2005
Clay County	Clay	Safe Room	PDMC 2005
Collins	St. Clair	Safe Room	PDMC 2005
City of Independence	Jackson	Bury Lines	PDMC 2005
Junction Hills School		Safe Room	PDMC 2005
Linn State Tech College	Osage	Safe Room	PDMC 2005
Mid-America Regional Council		Shelter Plan	PDMC 2005
MCC in Kansas City	Jackson	Safe Room	PDMC 2005
MCC in Kansas City	Jackson	Safe Room	PDMC 2005
MCC in Kansas City	Jackson	Safe Room	PDMC 2005
MCC in Kansas City	Jackson	Safe Room	PDMC 2005
MCC in Kansas City	Jackson	Safe Room	PDMC 2005
Pierce City Schools	Lawrence	Safe Room	PDMC 2005
Seymour Road Dist	Webster	Low Water	PDMC 2005
Sullivan County	Sullivan	Bridge	PDMC 2005
University of Missouri–Rolla	Phelps	DRU Plan	PDMC 2005
Webster County	Webster	Safe Room	PDMC 2005
West Plains Schools	Howell	Safe Room	PDMC 2005
Willow Springs Schools	Howell	Safe Room	PDMC 2005
Various Counties		Local HAZMIT Plans	PDMC 2005
State of Missouri		Closeouts/Mgmt	PDMC 2005
State of Missouri		State Plan Update	PDMC 2005
Ava	Douglas	Safe Room	PDMC 2006
Howell County	Howell	Safe Room (2)	PDMC 2006
Niangua	Webster	Safe Room	PDMC 2006
MCC in Kansas City	Jackson	Safe Room	PDMC 2006

Source: State Emergency Management Agency and Federal Emergency Management Agency

Appendix E: FEMA-Approved Local Hazard Mitigation Plans

County	Participating Jurisdiction	Plan Title	Approval Date	Target Update Date*
Andrew	Amazonia	Andrew County	11/30/2005	11/30/2010
Andrew	Andrew County	Andrew County	11/30/2005	11/30/2010
Andrew	Bolckow	Andrew County	11/30/2005	11/30/2010
Andrew	Cosby	Andrew County	11/30/2005	11/30/2010
Andrew	Country Club	Andrew County	11/30/2005	11/30/2010
Andrew	Fillmore	Andrew County	11/30/2005	11/30/2010
Andrew	Rea	Andrew County	11/30/2005	11/30/2010
Andrew	Rosendale	Andrew County	11/30/2005	11/30/2010
Andrew	Savannah	Andrew County	11/30/2005	11/30/2010
Atchison	Atchison County	Atchison County	12/6/2004	12/6/2009
Atchison	Fairfax	Atchison County	12/6/2004	12/6/2009
Atchison	Rock Port	Atchison County	12/6/2004	12/6/2009
Atchison	Tarkio	Atchison County	12/6/2004	12/6/2009
Atchison	Watson	Atchison County	12/6/2004	12/6/2009
Atchison	Westburo	Atchison County	12/6/2004	12/6/2009
Audrain	Audrain County	Audrain County	4/10/2006	4/10/2011
Audrain	Benton City	Audrain County	4/10/2006	4/10/2011
Audrain	Faber	Audrain County	4/10/2006	4/10/2011
Audrain	Laddonia	Audrain County	4/10/2006	4/10/2011
Audrain	Martinsburg	Audrain County	4/10/2006	4/10/2011
Audrain	Mexico	Audrain County	4/10/2006	4/10/2011
Audrain	Rush Hill	Audrain County	4/10/2006	4/10/2011
Audrain	Vandalia	Audrain County	4/10/2006	4/10/2011
Barry	Arrow Point	Barry County	11/17/2005	11/17/2010
Barry	Barry County	Barry County	11/17/2005	11/17/2010
Barry	Butterfield	Barry County	11/17/2005	11/17/2010
Barry	Cassville	Barry County	11/17/2005	11/17/2010
Barry	Chain-o-Lakes	Barry County	11/17/2005	11/17/2010
Barry	Emerald Beach	Barry County	11/17/2005	11/17/2010
Barry	Exter	Barry County	11/17/2005	11/17/2010
Barry	Monett	Barry County	11/17/2005	11/17/2010
Barry	Purdy	Barry County	11/17/2005	11/17/2010
Barry	Seligman	Barry County	11/17/2005	11/17/2010
Barry	Washburn	Barry County	11/17/2005	11/17/2010
Barry	Wheaton	Barry County	11/17/2005	11/17/2010
Bates	Adrian	Bates County	3/10/2005	3/10/2010
Bates	Amoret	Bates County	3/10/2005	3/10/2010
Bates	Amsterdam	Bates County	3/10/2005	3/10/2010
Bates	Bates County	Bates County	3/10/2005	3/10/2010
Bates	Butler	Bates County	3/10/2005	3/10/2010
Bates	Hume	Bates County	3/10/2005	3/10/2010

County	Participating Jurisdiction	Plan Title	Approval Date	Target Update Date*
Bates	Merwin	Bates County	3/10/2005	3/10/2010
Bates	Rich Hill	Bates County	3/10/2005	3/10/2010
Benton	Benton County	Benton County	11/16/2005	11/16/2010
Benton	Cole Camp	Benton County	11/16/2005	11/16/2010
Benton	Lincoln	Benton County	11/16/2005	11/16/2010
Benton	Warsaw	Benton County	11/16/2005	11/16/2010
Bollinger	Bollinger County	Bollinger County	1/23/2006	1/23/2011
Bollinger	Glen Allen	Bollinger County	1/23/2006	1/23/2011
Bollinger	Marble Hill	Bollinger County	1/23/2006	1/23/2011
Bollinger	Sedgewickville	Bollinger County	1/23/2006	1/23/2011
Boone	Ashland	Boone County	4/28/2005	4/28/2010
Boone	Boone County	Boone County	4/28/2005	4/28/2010
Boone	Centralia	Boone County	4/28/2005	4/28/2010
Boone	Columbia	Boone County	4/28/2005	4/28/2010
Boone	Hallsville	Boone County	4/28/2005	4/28/2010
Boone	Harrisburg	Boone County	4/28/2005	4/28/2010
Boone	Hartsburg	Boone County	4/28/2005	4/28/2010
Boone	Huntsdale	Boone County	4/28/2005	4/28/2010
Boone	Rocheport	Boone County	4/28/2005	4/28/2010
Boone	Sturgeon	Boone County	4/28/2005	4/28/2010
Buchanan	Agency	Buchanan County	11/4/2005	11/4/2010
Buchanan	Buchanan County	Buchanan County	11/4/2005	11/4/2010
Buchanan	Dekalb	Buchanan County	11/4/2005	11/4/2010
Buchanan	Easton	Buchanan County	11/4/2005	11/4/2010
Buchanan	Joseph	Buchanan County	11/4/2005	11/4/2010
Buchanan	Lewis & Clark	Buchanan County	11/4/2005	11/4/2010
Buchanan	Villages of Rushville	Buchanan County	11/4/2005	11/4/2010
Butler	Butler County	Butler County	5/6/2005	5/6/2010
Butler	Fisk	Butler County	5/6/2005	5/6/2010
Butler	Neelyville	Butler County	5/6/2005	5/6/2010
Butler	Popular Bluff	Butler County	5/6/2005	5/6/2010
Butler	Qulin	Butler County	5/6/2005	5/6/2010
Callaway	Auxvasse	Callaway County	5/23/2006	5/23/2011
Callaway	Callaway County	Callaway County	5/23/2006	5/23/2011
Callaway	Fulton	Callaway County	5/23/2006	5/23/2011
Callaway	Holts Summit	Callaway County	5/23/2006	5/23/2011
Callaway	Kingdom City	Callaway County	5/23/2006	5/23/2011
Callaway	Lake Mykee	Callaway County	5/23/2006	5/23/2011
Callaway	Mokane	Callaway County	5/23/2006	5/23/2011
Callaway	New Bloomfield	Callaway County	5/23/2006	5/23/2011
Cape Girardeau	Allenville	Cape Girardeau County	8/22/2005	8/22/2010
Cape Girardeau	Cape Girardeau	Cape Girardeau County	8/22/2005	8/22/2010
Cape Girardeau	Cape Girardeau County	Cape Girardeau County	8/22/2005	8/22/2010
Cape Girardeau	Dutchtown	Cape Girardeau County	8/22/2005	8/22/2010
Cape Girardeau	Gordonville	Cape Girardeau County	8/22/2005	8/22/2010

County	Participating Jurisdiction	Plan Title	Approval Date	Target Update Date*
Cape Girardeau	Jackson	Cape Girardeau County	8/22/2005	8/22/2010
Cape Girardeau	Oak Ridge	Cape Girardeau County	8/22/2005	8/22/2010
Cape Girardeau	Old Appleton	Cape Girardeau County	8/22/2005	8/22/2010
Cape Girardeau	Pocahontas	Cape Girardeau County	8/22/2005	8/22/2010
Carter	Carter County	Carter County	4/10/2006	4/10/2011
Carter	Ellsinore	Carter County	4/10/2006	4/10/2011
Carter	Grandin	Carter County	4/10/2006	4/10/2011
Carter	Van Buren	Carter County	4/10/2006	4/10/2011
Cass	Belton	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Cass County	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Cleveland	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Freeman	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Garden City	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Harrisonville	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Lake Annette	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Peculiar	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Pleasant Hill	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Raymore	Mid-America Regional Council	3/8/2005	3/8/2010
Cass	Strasburg	Mid-America Regional Council	3/8/2005	3/8/2010
Cass/Bates	Drexel	Mid-America Regional Council	3/8/2005	3/8/2010
Cedar	Cedar County	Cedar County	2/17/2006	2/17/2011
Cedar	El Dorado Springs	Cedar County	2/17/2006	2/17/2011
Cedar	Jerico Springs	Cedar County	2/17/2006	2/17/2011
Cedar	Stockton	Cedar County	2/17/2006	2/17/2011
Cedar	Umber View Heights	Cedar County	2/17/2006	2/17/2011
Christian	Billings	Christian County	11/17/2005	11/17/2010
Christian	Christian County	Christian County	11/17/2005	11/17/2010
Christian	Clever	Christian County	11/17/2005	11/17/2010
Christian	Fremont Hills	Christian County	11/17/2005	11/17/2010
Christian	Highlandville	Christian County	11/17/2005	11/17/2010
Christian	Nixa	Christian County	11/17/2005	11/17/2010
Christian	Ozark	Christian County	11/17/2005	11/17/2010
Christian	Saddlebrooke	Christian County	11/17/2005	11/17/2010
Christian	Sparta	Christian County	11/17/2005	11/17/2010

County	Participating Jurisdiction	Plan Title	Approval Date	Target Update Date*
Clark	Alexandria	Clark County	4/17/2006	4/17/2011
Clark	Clark County	Clark County	4/17/2006	4/17/2011
Clark	Kahoka	Clark County	4/17/2006	4/17/2011
Clark	Luray	Clark County	4/17/2006	4/17/2011
Clark	Revere	Clark County	4/17/2006	4/17/2011
Clark	Wayland	Clark County	4/17/2006	4/17/2011
Clark	Wyandonco	Clark County	4/17/2006	4/17/2011
Clay	Clay County	Mid-America Regional Council	3/8/2005	3/8/2010
Clay	Gladstone	Mid-America Regional Council	3/8/2005	3/8/2010
Clay	Kearney	Mid-America Regional Council	3/8/2005	3/8/2010
Clay	Liberty	Mid-America Regional Council	3/8/2005	3/8/2010
Clay	North Kansas City	Mid-America Regional Council	3/8/2005	3/8/2010
Clay	Randolph	Mid-America Regional Council	3/8/2005	3/8/2010
Clay	Smithville	Mid-America Regional Council	3/8/2005	3/8/2010
Clay/Ray	Excelsior Springs	Mid-America Regional Council	3/8/2005	3/8/2010
Clay/Ray	Lawson	Mid-America Regional Council	3/8/2005	3/8/2010
Clinton	Cameron	Clinton County	8/17/2005	8/17/2010
Clinton	Clinton County	Clinton County	8/17/2005	8/17/2010
Clinton	Gower	Clinton County	8/17/2005	8/17/2010
Clinton	Grayson	Clinton County	8/17/2005	8/17/2010
Clinton	Holt	Clinton County	8/17/2005	8/17/2010
Clinton	Lathrop	Clinton County	8/17/2005	8/17/2010
Clinton	Plattsburg	Clinton County	8/17/2005	8/17/2010
Clinton	Trimble	Clinton County	8/17/2005	8/17/2010
Cole	Cole County	Cole County	1/31/2006	1/31/2011
Cole	Jefferson	Cole County	1/31/2006	1/31/2011
Cole	Lohman	Cole County	1/31/2006	1/31/2011
Cole	Russellville	Cole County	1/31/2006	1/31/2011
Cole	St. Martin	Cole County	1/31/2006	1/31/2011
Cole	St. Thomas	Cole County	1/31/2006	1/31/2011
Cole	Wardsville	Cole County	1/31/2006	1/31/2011
Cooper	Blackwater	Cooper County	4/20/2006	4/20/2011
Cooper	Booneville	Cooper County	4/20/2006	4/20/2011
Cooper	Bunceton	Cooper County	4/20/2006	4/20/2011
Cooper	Cooper County	Cooper County	4/20/2006	4/20/2011
Cooper	Otterville	Cooper County	4/20/2006	4/20/2011

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Cooper	Pilot Grove	Cooper County	4/20/2006	4/20/2011
Cooper	Prairie Home	Cooper County	4/20/2006	4/20/2011
Crawford	Bourbon	Crawford County	1/24/2005	1/24/2010
Crawford	Crawford County	Crawford County	1/24/2005	1/24/2010
Crawford	Cuba	Crawford County	1/24/2005	1/24/2010
Crawford	Leasburg	Crawford County	1/24/2005	1/24/2010
Crawford	Steelville	Crawford County	1/24/2005	1/24/2010
Crawford	Sullivan	Crawford County	1/24/2005	1/24/2010
Crawford	West Sullivan	Crawford County	1/24/2005	1/24/2010
Dallas	Buffalo	Dallas County	1/31/2005	1/31/2010
Dallas	Dallas County	Dallas County	1/31/2005	1/31/2010
Dallas	Louisburg	Dallas County	1/31/2005	1/31/2010
Dallas	Urbana	Dallas County	1/31/2005	1/31/2010
Douglas	Ava	Douglas County	11/4/2005	11/4/2010
Douglas	Douglas County	Douglas County	11/4/2005	11/4/2010
Dunklin	Arbyrd	Dunklin County	2/7/2006	2/7/2011
Dunklin	Cardwell	Dunklin County	2/7/2006	2/7/2011
Dunklin	Clarkton	Dunklin County	2/7/2006	2/7/2011
Dunklin	Dunklin County	Dunklin County	2/7/2006	2/7/2011
Dunklin	Holcomb	Dunklin County	2/7/2006	2/7/2011
Dunklin	Kennett	Dunklin County	2/7/2006	2/7/2011
Dunklin	Malden	Dunklin County	2/7/2006	2/7/2011
Dunklin	Senath	Dunklin County	2/7/2006	2/7/2011
Franklin	Berger	East-West Gateway	11/23/2004	11/23/2009
Franklin	Franklin County	East-West Gateway	11/23/2004	11/23/2009
Franklin	Gerald	East-West Gateway	11/23/2004	11/23/2009
Franklin	Leslie	East-West Gateway	11/23/2004	11/23/2009
Franklin	Miramiguoa Park	East-West Gateway	11/23/2004	11/23/2009
Franklin	New Haven	East-West Gateway	11/23/2004	11/23/2009
Franklin	Oak Grove	East-West Gateway	11/23/2004	11/23/2009
Franklin	Pacific	East-West Gateway	11/23/2004	11/23/2009
Franklin	Parkway	East-West Gateway	11/23/2004	11/23/2009
Franklin	St. Clair	East-West Gateway	11/23/2004	11/23/2009
Franklin	Sullivan	East-West Gateway	11/23/2004	11/23/2009
Franklin	Union	East-West Gateway	11/23/2004	11/23/2009
Franklin	Washington	East-West Gateway	11/23/2004	11/23/2009
Gasconade	Bland	Gasconade County	11/15/2004	11/15/2009
Gasconade	Gasconade	Gasconade County	11/15/2004	11/15/2009
Gasconade	Gasconade County	Gasconade County	11/15/2004	11/15/2009
Gasconade	Hermann	Gasconade County	11/15/2004	11/15/2009
Gasconade	Morrison	Gasconade County	11/15/2004	11/15/2009
Gasconade	Owensville	Gasconade County	11/15/2004	11/15/2009
Gasconade	Rosebud	Gasconade County	11/15/2004	11/15/2009
Gentry	Albany	Gentry County	12/6/2004	12/6/2009
Gentry	Darlington	Gentry County	12/6/2004	12/6/2009

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Gentry	Gentry	Gentry County	12/6/2004	12/6/2009
Gentry	Gentry County	Gentry County	12/6/2004	12/6/2009
Gentry	King City	Gentry County	12/6/2004	12/6/2009
Gentry	McFall	Gentry County	12/6/2004	12/6/2009
Gentry	Stanberry	Gentry County	12/6/2004	12/6/2009
Green	Republic	Republic, City of	4/8/2005	4/8/2010
Greene	Greene County	Greene County/ Springfield	3/10/2005	3/10/2010
Greene	Springfield	Greene County/ Springfield	3/10/2005	3/10/2010
Greene	Willard	Willard, City of	12/14/2004	12/14/2009
Grundy	Brimson	Grundy County	3/14/2006	3/14/2011
Grundy	Galt	Grundy County	3/14/2006	3/14/2011
Grundy	Grundy County	Grundy County	3/14/2006	3/14/2011
Grundy	Laredo	Grundy County	3/14/2006	3/14/2011
Grundy	Spickard	Grundy County	3/14/2006	3/14/2011
Grundy	Tindall	Grundy County	3/14/2006	3/14/2011
Grundy	Trenton	Grundy County	3/14/2006	3/14/2011
Henry	Blairstown	Henry County	2/15/2006	2/15/2011
Henry	Brownington	Henry County	2/15/2006	2/15/2011
Henry	Calhoun	Henry County	2/15/2006	2/15/2011
Henry	Clinton	Henry County	2/15/2006	2/15/2011
Henry	Deepwater	Henry County	2/15/2006	2/15/2011
Henry	Henry County	Henry County	2/15/2006	2/15/2011
Henry	Montrose	Henry County	2/15/2006	2/15/2011
Henry	Urich	Henry County	2/15/2006	2/15/2011
Henry	Windsor	Henry County	2/15/2006	2/15/2011
Hickory	Cross Timbers	Hickory County	2/15/2006	2/15/2011
Hickory	Hermitage	Hickory County	2/15/2006	2/15/2011
Hickory	Hickory County	Hickory County	2/15/2006	2/15/2011
Hickory	Preston	Hickory County	2/15/2006	2/15/2011
Hickory	Weaubleau	Hickory County	2/15/2006	2/15/2011
Hickory	Wheatland	Hickory County	2/15/2006	2/15/2011
Holt	Big Lake	Holt County	8/1/2005	8/1/2010
Holt	Bigelow	Holt County	8/1/2005	8/1/2010
Holt	Corning	Holt County	8/1/2005	8/1/2010
Holt	Craig	Holt County	8/1/2005	8/1/2010
Holt	Forest City	Holt County	8/1/2005	8/1/2010
Holt	Fortescue	Holt County	8/1/2005	8/1/2010
Holt	Holt County	Holt County	8/1/2005	8/1/2010
Holt	Maitland	Holt County	8/1/2005	8/1/2010
Holt	Mound City	Holt County	8/1/2005	8/1/2010
Holt	Oregon	Holt County	8/1/2005	8/1/2010
Howard	Armstrong	Howard County	2/27/2006	2/27/2011
Howard	Cities of Fayette	Howard County	2/27/2006	2/27/2011

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Howard	Glasgow	Howard County	2/27/2006	2/27/2011
Howard	Howard County	Howard County	2/27/2006	2/27/2011
Howard	New Franklin	Howard County	2/27/2006	2/27/2011
Howell	Brandsville	Howell County	3/7/2005	3/7/2010
Howell	Howell County	Howell County	3/7/2005	3/7/2010
Howell	Mountain View	Howell County	3/7/2005	3/7/2010
Howell	West Plains	Howell County	3/7/2005	3/7/2010
Howell	Willow Springs	Howell County	3/7/2005	3/7/2010
Iron	Annapolis	Iron County	1/19/2006	1/19/2011
Iron	Arcadia	Iron County	1/19/2006	1/19/2011
Iron	Des Arc	Iron County	1/19/2006	1/19/2011
Iron	Iron County	Iron County	1/19/2006	1/19/2011
Iron	Ironton	Iron County	1/19/2006	1/19/2011
Iron	Pilot Knob	Iron County	1/19/2006	1/19/2011
Jackson	Blue Springs	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Buckner	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Grain Valley	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Grandview	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Greenwood	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Independence	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Jackson County	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Lake Lotawana	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Lake Tapawingo	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Levasy	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Lone Jack	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson	Raytown	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson/Cass/ Clay/Platte	Kansas City	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson/Cass	Lees Summit	Mid-America Regional Council	3/8/2005	3/8/2010
Jackson/ Lafayette	Oak Grove	Mid-America Regional Council	3/8/2005	3/8/2010
Jasper	Airport Drive	Jasper County	1/6/2005	1/6/2010
Jasper	Alba	Jasper County	1/6/2005	1/6/2010

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Jasper	Asbury	Jasper County	1/6/2005	1/6/2010
Jasper	Avilla	Jasper County	1/6/2005	1/6/2010
Jasper	Carl Junction	Jasper County	1/6/2005	1/6/2010
Jasper	Carterville	Jasper County	1/6/2005	1/6/2010
Jasper	Carthage	Jasper County	1/6/2005	1/6/2010
Jasper	Carytown	Jasper County	1/6/2005	1/6/2010
Jasper	Duenweg	Jasper County	1/6/2005	1/6/2010
Jasper	Duquesne	Jasper County	1/6/2005	1/6/2010
Jasper	Fidelity	Jasper County	1/6/2005	1/6/2010
Jasper	Jasper	Jasper County	1/6/2005	1/6/2010
Jasper	Jasper County	Jasper County	1/6/2005	1/6/2010
Jasper	Joplin	Jasper County	1/6/2005	1/6/2010
Jasper	La Russell	Jasper County	1/6/2005	1/6/2010
Jasper	Neck City	Jasper County	1/6/2005	1/6/2010
Jasper	Oronogo	Jasper County	1/6/2005	1/6/2010
Jasper	Purchell	Jasper County	1/6/2005	1/6/2010
Jasper	Reeds	Jasper County	1/6/2005	1/6/2010
Jasper	Sarcoxie	Jasper County	1/6/2005	1/6/2010
Jasper	Waco	Jasper County	1/6/2005	1/6/2010
Jasper	Webb City	Jasper County	1/6/2005	1/6/2010
Jefferson	Arnold	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Byrnes Mill	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Cedar Hill Lakes	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Crystal City	East-West Gateway	11/23/2004	11/23/2009
Jefferson	De Soto	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Festus	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Herculaneum	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Hillsboro	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Jefferson County	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Kimmswick	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Olympian Village	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Parkdale	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Pevely	East-West Gateway	11/23/2004	11/23/2009
Jefferson	Scotsdale	East-West Gateway	11/23/2004	11/23/2009
Johnson	Centerview	Johnson County	11/2/2005	11/2/2010
Johnson	Chilhowee	Johnson County	11/2/2005	11/2/2010
Johnson	Holden	Johnson County	11/2/2005	11/2/2010
Johnson	Johnson County	Johnson County	11/2/2005	11/2/2010
Johnson	Kingsville	Johnson County	11/2/2005	11/2/2010
Johnson	Knob Noster	Johnson County	11/2/2005	11/2/2010
Johnson	Latour	Johnson County	11/2/2005	11/2/2010
Johnson	Leeton	Johnson County	11/2/2005	11/2/2010
Johnson	Warrensburg	Johnson County	11/2/2005	11/2/2010
Lafayette	Alma	Lafayette County	11/3/2005	11/3/2010
Lafayette	Aullville	Lafayette County	11/3/2005	11/3/2010

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Lafayette	Bates City	Lafayette County	11/3/2005	11/3/2010
Lafayette	Concordia	Lafayette County	11/3/2005	11/3/2010
Lafayette	Corder	Lafayette County	11/3/2005	11/3/2010
Lafayette	Dover	Lafayette County	11/3/2005	11/3/2010
Lafayette	Higginsville	Lafayette County	11/3/2005	11/3/2010
Lafayette	Lafayette County	Lafayette County	11/3/2005	11/3/2010
Lafayette	Lake Lafayette	Lafayette County	11/3/2005	11/3/2010
Lafayette	Lexington	Lafayette County	11/3/2005	11/3/2010
Lafayette	Mayview	Lafayette County	11/3/2005	11/3/2010
Lafayette	Napoleon	Lafayette County	11/3/2005	11/3/2010
Lafayette	Odessa	Lafayette County	11/3/2005	11/3/2010
Lafayette	Waverly	Lafayette County	11/3/2005	11/3/2010
Lafayette	Wellington	Lafayette County	11/3/2005	11/3/2010
Lawrence	Aurora	Lawrence County	4/12/2005	4/12/2010
Lawrence	Freistatt	Lawrence County	4/12/2005	4/12/2010
Lawrence	Halltown	Lawrence County	4/12/2005	4/12/2010
Lawrence	Hoberg	Lawrence County	4/12/2005	4/12/2010
Lawrence	Lawrence County	Lawrence County	4/12/2005	4/12/2010
Lawrence	Marionville	Lawrence County	4/12/2005	4/12/2010
Lawrence	Miller	Lawrence County	4/12/2005	4/12/2010
Lawrence	Monett	Lawrence County	4/12/2005	4/12/2010
Lawrence	Mount Vernon	Lawrence County	4/12/2005	4/12/2010
Lawrence	Pierce City	Lawrence County	4/12/2005	4/12/2010
Lawrence	Stotts City	Lawrence County	4/12/2005	4/12/2010
Lawrence	Verona	Lawrence County	4/12/2005	4/12/2010
Lewis	Canton	Lewis County	4/26/2005	4/26/2010
Lewis	Ewing	Lewis County	4/26/2005	4/26/2010
Lewis	LaGrange	Lewis County	4/26/2005	4/26/2010
Lewis	LeBelle	Lewis County	4/26/2005	4/26/2010
Lewis	Lewis County	Lewis County	4/26/2005	4/26/2010
Lewis	Lewistown	Lewis County	4/26/2005	4/26/2010
Lewis	Monticello	Lewis County	4/26/2005	4/26/2010
Lincoln	Chain of Rocks	Lincoln County	11/23/2004	11/23/2009
Lincoln	Elsberry	Lincoln County	11/23/2004	11/23/2009
Lincoln	Foley	Lincoln County	11/23/2004	11/23/2009
Lincoln	Fountain N' Lakes	Lincoln County	11/23/2004	11/23/2009
Lincoln	Hawk Point	Lincoln County	11/23/2004	11/23/2009
Lincoln	Lincoln County	Lincoln County	11/23/2004	11/23/2009
Lincoln	Moscow Mills	Lincoln County	11/23/2004	11/23/2009
Lincoln	Old Monroe	Lincoln County	11/23/2004	11/23/2009
Lincoln	Silex	Lincoln County	11/23/2004	11/23/2009
Lincoln	Troy	Lincoln County	11/23/2004	11/23/2009
Lincoln	Truxton	Lincoln County	11/23/2004	11/23/2009
Lincoln	Whteside	Lincoln County	11/23/2004	11/23/2009
Lincoln	Winfield	Lincoln County	11/23/2004	11/23/2009

County	Participating Jurisdiction	Plan Title	Approval Date	Target Update Date*
Livingston	Chillicothe	Livingston County	3/9/2006	3/9/2011
Livingston	Chula	Livingston County	3/9/2006	3/9/2011
Livingston	Laredo	Livingston County	3/9/2006	3/9/2011
Livingston	Livingston County	Livingston County	3/9/2006	3/9/2011
Livingston	Moorsville	Livingston County	3/9/2006	3/9/2011
Livingston	Utica	Livingston County	3/9/2006	3/9/2011
Livingston	Wheeling	Livingston County	3/9/2006	3/9/2011
Macon	Atlanta	Macon County	4/20/2006	4/20/2011
Macon	Bevier	Macon County	4/20/2006	4/20/2011
Macon	Callao	Macon County	4/20/2006	4/20/2011
Macon	Elmer	Macon County	4/20/2006	4/20/2011
Macon	Ethel	Macon County	4/20/2006	4/20/2011
Macon	LaPlata	Macon County	4/20/2006	4/20/2011
Macon	Macon	Macon County	4/20/2006	4/20/2011
Macon	Macon County	Macon County	4/20/2006	4/20/2011
Macon	South Gilford	Macon County	4/20/2006	4/20/2011
Madison	Cobalt Village	Madison County	2/22/2006	2/22/2011
Madison	Fredericktown	Madison County	2/22/2006	2/22/2011
Madison	Madison County	Madison County	2/22/2006	2/22/2011
Madison	Marquand Village	Madison County	2/22/2006	2/22/2011
Maries	Belle	Maries County	8/22/2006	8/22/2011
Maries	Maries County	Maries County	8/22/2006	8/22/2011
Maries	Vienna	Maries County	8/22/2006	8/22/2011
Marion	Hannibal	Marion County	12/17/2004	12/17/2009
Marion	Marion County	Marion County	12/17/2004	12/17/2009
Marion	Palmyra	Marion County	12/17/2004	12/17/2009
McDonald	Anderson	McDonald County	1/23/2006	1/23/2011
McDonald	Goodman	McDonald County	1/23/2006	1/23/2011
McDonald	Lanagan	McDonald County	1/23/2006	1/23/2011
McDonald	McDonald County	McDonald County	1/23/2006	1/23/2011
McDonald	Noel	McDonald County	1/23/2006	1/23/2011
McDonald	Pineville	McDonald County	1/23/2006	1/23/2011
McDonald	Southwest City	McDonald County	1/23/2006	1/23/2011
Mercer	Lineville	Mercer County	8/15/2005	8/15/2010
Mercer	Mercer	Mercer County	8/15/2005	8/15/2010
Mercer	Mercer County	Mercer County	8/15/2005	8/15/2010
Mercer	Princeton	Mercer County	8/15/2005	8/15/2010
Mississippi	Anniston	Mississippi County	1/10/2006	1/10/2011
Mississippi	Bertrand	Mississippi County	1/10/2006	1/10/2011
Mississippi	Charleston	Mississippi County	1/10/2006	1/10/2011
Mississippi	East Prairie	Mississippi County	1/10/2006	1/10/2011
Mississippi	Mississippi County	Mississippi County	1/10/2006	1/10/2011
Mississippi	Pinhook	Mississippi County	1/10/2006	1/10/2011
Mississippi	Wyatt	Mississippi County	1/10/2006	1/10/2011
Moniteau	California	Moniteau County	4/20/2006	4/20/2011

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Moniteau	Clarksburg	Moniteau County	4/20/2006	4/20/2011
Moniteau	Lupus	Moniteau County	4/20/2006	4/20/2011
Moniteau	Moniteau County	Moniteau County	4/20/2006	4/20/2011
Moniteau	Tipton	Moniteau County	4/20/2006	4/20/2011
Monroe	Holliday	Monroe County	3/24/2006	3/24/2011
Monroe	Madison	Monroe County	3/24/2006	3/24/2011
Monroe	Monroe City	Monroe County	3/24/2006	3/24/2011
Monroe	Monroe County	Monroe County	3/24/2006	3/24/2011
Monroe	Paris	Monroe County	3/24/2006	3/24/2011
Monroe	Stoutsville	Monroe County	3/24/2006	3/24/2011
Montgomery	Bellflower	Montgomery County	8/31/2004	8/31/2009
Montgomery	High Hill	Montgomery County	8/31/2004	8/31/2009
Montgomery	Jonesburg	Montgomery County	8/31/2004	8/31/2009
Montgomery	Middletown	Montgomery County	8/31/2004	8/31/2009
Montgomery	Montgomery City	Montgomery County	8/31/2004	8/31/2009
Montgomery	Montgomery County	Montgomery County	8/31/2004	8/31/2009
Montgomery	New Florence	Montgomery County	8/31/2004	8/31/2009
Montgomery	Rhineland	Montgomery County	8/31/2004	8/31/2009
Montgomery	Wellsville	Montgomery County	8/31/2004	8/31/2009
New Madrid	Gideon	New Madrid County	11/7/2005	11/7/2010
New Madrid	Howardville	New Madrid County	11/7/2005	11/7/2010
New Madrid	Lilbourn	New Madrid County	11/7/2005	11/7/2010
New Madrid	Marston	New Madrid County	11/7/2005	11/7/2010
New Madrid	Matthews	New Madrid County	11/7/2005	11/7/2010
New Madrid	Morehouse	New Madrid County	11/7/2005	11/7/2010
New Madrid	New Madrid County	New Madrid County	11/7/2005	11/7/2010
New Madrid	Parma	New Madrid County	11/7/2005	11/7/2010
New Madrid	Portageville	New Madrid County	11/7/2005	11/7/2010
New Madrid	Risco	New Madrid County	11/7/2005	11/7/2010
New Madrid	Tallapoosa	New Madrid County	11/7/2005	11/7/2010
Newton	Cliff Village	Newton County	12/14/2004	12/14/2009
Newton	Dennis Acres	Newton County	12/14/2004	12/14/2009
Newton	Diamond	Newton County	12/14/2004	12/14/2009
Newton	Fairview	Newton County	12/14/2004	12/14/2009
Newton	Granby	Newton County	12/14/2004	12/14/2009
Newton	Grand Falls Plaza	Newton County	12/14/2004	12/14/2009
Newton	Joplin	Newton County	12/14/2004	12/14/2009
Newton	Leawood	Newton County	12/14/2004	12/14/2009
Newton	Loma Linda	Newton County	12/14/2004	12/14/2009
Newton	Neosho	Newton County	12/14/2004	12/14/2009
Newton	Newton County	Newton County	12/14/2004	12/14/2009
Newton	Newtonia	Newton County	12/14/2004	12/14/2009
Newton	Reddings Mill	Newton County	12/14/2004	12/14/2009
Newton	Richey	Newton County	12/14/2004	12/14/2009
Newton	Saginaw	Newton County	12/14/2004	12/14/2009

County	Participating Jurisdiction	Plan Title	Approval Date	Target Update Date*
Newton	Seneca	Newton County	12/14/2004	12/14/2009
Newton	Shoal Creek Drive	Newton County	12/14/2004	12/14/2009
Newton	Shoal Creek Estates	Newton County	12/14/2004	12/14/2009
Newton	Silver Creed	Newton County	12/14/2004	12/14/2009
Newton	Stark City	Newton County	12/14/2004	12/14/2009
Newton	Stella	Newton County	12/14/2004	12/14/2009
Newton	Wentworth	Newton County	12/14/2004	12/14/2009
Oregon	Alton	Oregon County	11/9/2005	11/9/2010
Oregon	Koshkonong	Oregon County	11/9/2005	11/9/2010
Oregon	Oregon County	Oregon County	11/9/2005	11/9/2010
Oregon	Thayer	Oregon County	11/9/2005	11/9/2010
Osage	Argyle	Osage County	3/8/2005	3/8/2010
Osage	Chamois	Osage County	3/8/2005	3/8/2010
Osage	Freeburg	Osage County	3/8/2005	3/8/2010
Osage	Linn	Osage County	3/8/2005	3/8/2010
Osage	Meta	Osage County	3/8/2005	3/8/2010
Osage	Osage County	Osage County	3/8/2005	3/8/2010
Osage	Westphalia	Osage County	3/8/2005	3/8/2010
Ozark	Bakerfield	Ozark County	1/10/2006	1/10/2011
Ozark	Gainsville	Ozark County	1/10/2006	1/10/2011
Ozark	Ozark County	Ozark County	1/10/2006	1/10/2011
Ozark	Theodosia	Ozark County	1/10/2006	1/10/2011
Pemiscot	Caruthersville	Pemiscot County	1/30/2006	1/30/2011
Pemiscot	Cooter	Pemiscot County	1/30/2006	1/30/2011
Pemiscot	Hayti	Pemiscot County	1/30/2006	1/30/2011
Pemiscot	Hayti Heights	Pemiscot County	1/30/2006	1/30/2011
Pemiscot	Homestown	Pemiscot County	1/30/2006	1/30/2011
Pemiscot	Pascola	Pemiscot County	1/30/2006	1/30/2011
Pemiscot	Pemiscot County	Pemiscot County	1/30/2006	1/30/2011
Perry	Altenburg	Perry County	12/27/2005	12/27/2010
Perry	Frohna	Perry County	12/27/2005	12/27/2010
Perry	Perry County	Perry County	12/27/2005	12/27/2010
Perry	Perryville	Perry County	12/27/2005	12/27/2010
Pettis	Green Ridge	Pettis County	8/11/2005	8/11/2010
Pettis	Hughesville	Pettis County	8/11/2005	8/11/2010
Pettis	La Monte	Pettis County	8/11/2005	8/11/2010
Pettis	Pettis County	Pettis County	8/11/2005	8/11/2010
Pettis	Sedalia	Pettis County	8/11/2005	8/11/2010
Pettis	Smithton	Pettis County	8/11/2005	8/11/2010
Phelps	Doolittle	Phelps County	11/15/2004	11/15/2009
Phelps	Edgar Springs	Phelps County	11/15/2004	11/15/2009
Phelps	Newburg	Phelps County	11/15/2004	11/15/2009
Phelps	Phelps County	Phelps County	11/15/2004	11/15/2009
Phelps	Rolla	Phelps County	11/15/2004	11/15/2009
Phelps	St. James	Phelps County	11/15/2004	11/15/2009

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Pike	Annada	Pike County	12/17/2004	12/17/2009
Pike	Bowling Green	Pike County	12/17/2004	12/17/2009
Pike	Clarksville	Pike County	12/17/2004	12/17/2009
Pike	Curryville	Pike County	12/17/2004	12/17/2009
Pike	Eolia	Pike County	12/17/2004	12/17/2009
Pike	Frankford	Pike County	12/17/2004	12/17/2009
Pike	Louisiana	Pike County	12/17/2004	12/17/2009
Pike	Paynesville	Pike County	12/17/2004	12/17/2009
Pike	Pike County	Pike County	12/17/2004	12/17/2009
Platte	Edgerton	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Farley	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Ferrelview	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Parkville	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Platte City	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Platte County	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Platte Woods	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Ridgely	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Riverside	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Weatherby Lake	Mid-America Regional Council	3/8/2005	3/8/2010
Platte	Weston	Mid-America Regional Council	3/8/2005	3/8/2010
Polk	Aldrich	Polk County	12/7/2005	12/7/2010
Polk	Bolivar	Polk County	12/7/2005	12/7/2010
Polk	Fair Play	Polk County	12/7/2005	12/7/2010
Polk	Flemington	Polk County	12/7/2005	12/7/2010
Polk	Goodnight	Polk County	12/7/2005	12/7/2010
Polk	Halfway	Polk County	12/7/2005	12/7/2010
Polk	Humansville	Polk County	12/7/2005	12/7/2010
Polk	Morrisville	Polk County	12/7/2005	12/7/2010
Polk	Pleasant Hope	Polk County	12/7/2005	12/7/2010
Polk	Polk County	Polk County	12/7/2005	12/7/2010
Putnam	Livonia	Putnam County	3/14/2006	3/14/2011
Putnam	Lucerne	Putnam County	3/14/2006	3/14/2011
Putnam	Powersville	Putnam County	3/14/2006	3/14/2011
Putnam	Putnam County	Putnam County	3/14/2006	3/14/2011
Putnam	Unionville	Putnam County	3/14/2006	3/14/2011

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Putnam	Worthington	Putnam County	3/14/2006	3/14/2011
Ralls	Center	Ralls County	12/17/2004	12/17/2009
Ralls	New London	Ralls County	12/17/2004	12/17/2009
Ralls	Perry	Ralls County	12/17/2004	12/17/2009
Ralls	Ralls County	Ralls County	12/17/2004	12/17/2009
Ralls	Rensselaer	Ralls County	12/17/2004	12/17/2009
Ray	Fleming	Mid-America Regional Council	3/8/2005	3/8/2010
Ray	Orrick	Mid-America Regional Council	3/8/2005	3/8/2010
Ray	Ray County	Mid-America Regional Council	3/8/2005	3/8/2010
Ray	Richmond	Mid-America Regional Council	3/8/2005	3/8/2010
Ray	Wood Heights	Mid-America Regional Council	3/8/2005	3/8/2010
Reynolds	Bunker	Reynolds County	3/27/2006	3/27/2011
Reynolds	Centerville	Reynolds County	3/27/2006	3/27/2011
Reynolds	Ellington	Reynolds County	3/27/2006	3/27/2011
Reynolds	Reynolds County	Reynolds County	3/27/2006	3/27/2011
Ripley	Doniphan	Ripley County	9/20/2004	9/20/2009
Ripley	Naylor	Ripley County	9/20/2004	9/20/2009
Ripley	Ripley County	Ripley County	9/20/2004	9/20/2009
Saline	Arrow Rock	Saline County	8/17/2005	8/17/2010
Saline	Blackburn	Saline County	8/17/2005	8/17/2010
Saline	Gilliam	Saline County	8/17/2005	8/17/2010
Saline	Grand Pass	Saline County	8/17/2005	8/17/2010
Saline	Malta Bend	Saline County	8/17/2005	8/17/2010
Saline	Marshall	Saline County	8/17/2005	8/17/2010
Saline	Mt. Leonard	Saline County	8/17/2005	8/17/2010
Saline	Nelson	Saline County	8/17/2005	8/17/2010
Saline	Saline County	Saline County	8/17/2005	8/17/2010
Saline	Slater	Saline County	8/17/2005	8/17/2010
Saline	Sweet Springs	Saline County	8/17/2005	8/17/2010
Scott	Blodgett	Scott County	12/13/2005	12/13/2010
Scott	Chaffee	Scott County	12/13/2005	12/13/2010
Scott	Oran	Scott County	12/13/2005	12/13/2010
Scott	Scott City	Scott County	12/13/2005	12/13/2010
Scott	Scott County	Scott County	12/13/2005	12/13/2010
Scott	Sikeston	Scott County	12/13/2005	12/13/2010
Scott	Vanduser	Scott County	12/13/2005	12/13/2010
Shannon	Birch Tree	Shannon County	2/24/2006	2/24/2011
Shannon	Eminence	Shannon County	2/24/2006	2/24/2011
Shannon	Shannon County	Shannon County	2/24/2006	2/24/2011
Shannon	Winona	Shannon County	2/24/2006	2/24/2011

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Shelby	Bethel	Shelby County	4/10/2006	4/10/2011
Shelby	Clarence	Shelby County	4/10/2006	4/10/2011
Shelby	Hunnewell	Shelby County	4/10/2006	4/10/2011
Shelby	Leonard	Shelby County	4/10/2006	4/10/2011
Shelby	Shelbina	Shelby County	4/10/2006	4/10/2011
Shelby	Shelby County	Shelby County	4/10/2006	4/10/2011
Shelby	Shelbyville	Shelby County	4/10/2006	4/10/2011
St. Charles	Augusta	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Cottleville	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Dardenne Prairie	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Flint Hill	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Foristell	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Josephville	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Lake St.Louis	East-West Gateway	11/23/2004	11/23/2009
St. Charles	New Melle	East-West Gateway	11/23/2004	11/23/2009
St. Charles	O'Fallon	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Portage Des Sioux	East-West Gateway	11/23/2004	11/23/2009
St. Charles	St. Charles	East-West Gateway	11/23/2004	11/23/2009
St. Charles	St. Charles County	East-West Gateway	11/23/2004	11/23/2009
St. Charles	St. Paul	East-West Gateway	11/23/2004	11/23/2009
St. Charles	St. Peters	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Weldon Spring	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Weldon Spring Heights	East-West Gateway	11/23/2004	11/23/2009
St. Charles	Wentzville	East-West Gateway	11/23/2004	11/23/2009
St. Charles	West Alton	East-West Gateway	11/23/2004	11/23/2009
St. Clair	Appleton	St. Clair County	3/10/2005	3/10/2010
St. Clair	Collins	St. Clair County	3/10/2005	3/10/2010
St. Clair	Osceola	St. Clair County	3/10/2005	3/10/2010
St. Clair	St. Clair County	St. Clair County	3/10/2005	3/10/2010
St. Francois	Bismarck	St. Francois County	8/9/2005	8/9/2010
St. Francois	Bonne Terre	St. Francois County	8/9/2005	8/9/2010
St. Francois	Desloge	St. Francois County	8/9/2005	8/9/2010
St. Francois	Farmington	St. Francois County	8/9/2005	8/9/2010
St. Francois	Iron Mountain Lake	St. Francois County	8/9/2005	8/9/2010
St. Francois	Leadington	St. Francois County	8/9/2005	8/9/2010
St. Francois	Leadwood	St. Francois County	8/9/2005	8/9/2010
St. Francois	Park Hills	St. Francois County	8/9/2005	8/9/2010
St. Francois	St. Francois County	St. Francois County	8/9/2005	8/9/2010
St. Genevieve	Bloomsdale	St. Genevieve County	2/2/2006	2/2/2011
St. Genevieve	St. Genevieve	St. Genevieve County	2/2/2006	2/2/2011
St. Genevieve	St. Genevieve County	St. Genevieve County	2/2/2006	2/2/2011
St. Genevieve	St. Mary	St. Genevieve County	2/2/2006	2/2/2011
St. Louis	Ballwin	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Bella Villa	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Bellefontaine Neighbors	East-West Gateway	11/23/2004	11/23/2009

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St. Louis	Bellerive Acres	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Bel-Nor	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Bel-Ridge	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Berkeley	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Beverly Hills	East-West Gateway	11/23/2004	11/23/2009
St. Louis	BlackJack	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Breckenridge Hills	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Brentwood	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Bridgeton	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Calverton Park	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Champ	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Charlack	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Chesterfield	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Clarkson Valley	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Clayton	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Cool Valley	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Country Club Hills	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Country Life Acres	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Crestwood	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Creve Coeur	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Crystal Lake Park	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Dellwood	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Des Peres	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Edmundson	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Ellisville	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Eureka	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Fenton	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Ferguson	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Flordell Hills	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Florissant	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Frontenac	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Glen Echo Park	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Glendale	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Grantwood Village	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Green Park	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Greendale	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Hanley Hills	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Hazelwood	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Hillsdale	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Huntleigh	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Jennings	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Kinloch	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Ladue	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Lakeshire	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Mackenzie	East-West Gateway	11/23/2004	11/23/2009

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St. Louis	Manchester	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Maplewood	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Marlborough	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Maryland Heights	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Moline Acres	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Normandy	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Northwoods	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Norwood Court	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Oakland	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Olivette	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Overland	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Pagedale	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Pasadena Hills	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Pasadena Park	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Pine Lawn	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Richmond Heights	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Riverview	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Rock Hill	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Shrewsbury	East-West Gateway	11/23/2004	11/23/2009
St. Louis	St. Ann	East-West Gateway	11/23/2004	11/23/2009
St. Louis	St. George	East-West Gateway	11/23/2004	11/23/2009
St. Louis	St. John	East-West Gateway	11/23/2004	11/23/2009
St. Louis	St. Louis County	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Sunset Hills	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Town and Country	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Twin Oaks	East-West Gateway	11/23/2004	11/23/2009
St. Louis	University City	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Uplands Park	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Valley Park	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Velda City	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Velda Village Hills	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Vinita Park	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Vinita Terrace	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Warson Woods	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Webster Groves	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Wellston City	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Westwood	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Wilbur Park	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Wildwood	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Winchester	East-West Gateway	11/23/2004	11/23/2009
St. Louis	Woodson Terrace	East-West Gateway	11/23/2004	11/23/2009
St. Louis City	St. Louis City	East-West Gateway	11/23/2004	11/23/2009
Stoddard	Advance	Stoddard County	1/17/2006	1/17/2011
Stoddard	Bell City	Stoddard County	1/17/2006	1/17/2011
Stoddard	Bernie	Stoddard County	1/17/2006	1/17/2011

County	Participating Jurisdiction	Plan Title	Approval Date	Target Update Date*
Stoddard	Bloomfield	Stoddard County	1/17/2006	1/17/2011
Stoddard	Dexter	Stoddard County	1/17/2006	1/17/2011
Stoddard	Dudley	Stoddard County	1/17/2006	1/17/2011
Stoddard	Essex	Stoddard County	1/17/2006	1/17/2011
Stoddard	Penermon	Stoddard County	1/17/2006	1/17/2011
Stoddard	Puxico	Stoddard County	1/17/2006	1/17/2011
Stoddard	Stoddard County	Stoddard County	1/17/2006	1/17/2011
Sullivan	Green	Sullivan County	4/28/2005	4/28/2010
Sullivan	Green Castle	Sullivan County	4/28/2005	4/28/2010
Sullivan	Harris	Sullivan County	4/28/2005	4/28/2010
Sullivan	Humphreys	Sullivan County	4/28/2005	4/28/2010
Sullivan	Milan	Sullivan County	4/28/2005	4/28/2010
Sullivan	Newton	Sullivan County	4/28/2005	4/28/2010
Sullivan	Osgood	Sullivan County	4/28/2005	4/28/2010
Sullivan	Sullivan County	Sullivan County	4/28/2005	4/28/2010
Texas	Cabool	Texas County	12/17/2004	12/17/2009
Texas	Houston	Texas County	12/17/2004	12/17/2009
Texas	Licking	Texas County	12/17/2004	12/17/2009
Texas	Plato	Texas County	12/17/2004	12/17/2009
Texas	Raymondville	Texas County	12/17/2004	12/17/2009
Texas	Summersville	Texas County	12/17/2004	12/17/2009
Texas	Texas County	Texas County	12/17/2004	12/17/2009
Vernon	Bronaugh	Vernon County	2/17/2006	2/17/2011
Vernon	Deerfield	Vernon County	2/17/2006	2/17/2011
Vernon	Harwood	Vernon County	2/17/2006	2/17/2011
Vernon	Metz	Vernon County	2/17/2006	2/17/2011
Vernon	Milo	Vernon County	2/17/2006	2/17/2011
Vernon	Moundville	Vernon County	2/17/2006	2/17/2011
Vernon	Nevada	Vernon County	2/17/2006	2/17/2011
Vernon	Richards	Vernon County	2/17/2006	2/17/2011
Vernon	Schell City	Vernon County	2/17/2006	2/17/2011
Vernon	Sheldon	Vernon County	2/17/2006	2/17/2011
Vernon	Stotesbury	Vernon County	2/17/2006	2/17/2011
Vernon	Vernon County	Vernon County	2/17/2006	2/17/2011
Vernon	Walker	Vernon County	2/17/2006	2/17/2011
Warren	Innsbrook	Warren County	11/23/2004	11/23/2009
Warren	Marthasville	Warren County	11/23/2004	11/23/2009
Warren	Pendleton	Warren County	11/23/2004	11/23/2009
Warren	Truesdale	Warren County	11/23/2004	11/23/2009
Warren	Warren County	Warren County	11/23/2004	11/23/2009
Warren	Warrenton	Warren County	11/23/2004	11/23/2009
Warren	Wright City	Warren County	11/23/2004	11/23/2009
Washington	Caledonia	Washington County	3/28/2005	3/28/2010
Washington	Irondale	Washington County	3/28/2005	3/28/2010
Washington	Mineral Point	Washington County	3/28/2005	3/28/2010

County	Participating Jurisdiction	Plan Title	Approval Date	Target Update Date*
Washington	Potosi	Washington County	3/28/2005	3/28/2010
Washington	Washington County	Washington County	3/28/2005	3/28/2010
Wayne	Greenville	Wayne County	3/20/2006	3/20/2011
Wayne	Mill Spring	Wayne County	3/20/2006	3/20/2011
Wayne	Piedmont	Wayne County	3/20/2006	3/20/2011
Wayne	Wayne County	Wayne County	3/20/2006	3/20/2011
Wayne	Williamsville	Wayne County	3/20/2006	3/20/2011
Webster	Diggins	Webster County	3/31/2005	3/31/2010
Webster	Fordland	Webster County	3/31/2005	3/31/2010
Webster	Marshfield	Webster County	3/31/2005	3/31/2010
Webster	Rogersville	Webster County	3/31/2005	3/31/2010
Webster	Seymour	Webster County	3/31/2005	3/31/2010
Webster	Webster County	Webster County	3/31/2005	3/31/2010
Worth	Allendale	Worth County	11/2/2005	11/2/2010
Worth	Denver	Worth County	11/2/2005	11/2/2010
Worth	Grant City	Worth County	11/2/2005	11/2/2010
Worth	Sheridan	Worth County	11/2/2005	11/2/2010
Worth	Worth	Worth County	11/2/2005	11/2/2010
Worth	Worth County	Worth County	11/2/2005	11/2/2010
Wright	Hartville	Wright County	11/4/2005	11/4/2010
Wright	Mansfield	Wright County	11/4/2005	11/4/2010
Wright	Mountain Grove	Wright County	11/4/2005	11/4/2010
Wright	Norwood	Wright County	11/4/2005	11/4/2010
Wright	Wright County	Wright County	11/4/2005	11/4/2010

Note:
* Plans must be updated every five years.
Source: FEMA Web Site, October 26, 2006

Appendix F: HAZUS-MH Earthquake Results
2,500 Year Scenario Global Summary Report

HAZUS-MH: Earthquake Event Report

Region Name: ***MO_2500yearEarthquake***

Earthquake Scenario: ***2500 year probabilistic statewide***

Print Date: ***June 11, 2007***

Disclaimer:
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 115 county(ies) from the following state(s):

Missouri

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 69,638.23 square miles and contains 1,320 census tracts. There are over 2,194 thousand households in the region and has a total population of 5,595,211 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 1,770 thousand buildings in the region with a total building replacement value (excluding contents) of 334,877 (millions of dollars). Approximately 99.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 120,219 and 105,417 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 1,770 thousand buildings in the region which have an aggregate total replacement value of 334,877 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 67% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 143 hospitals in the region with a total bed capacity of 23,310 beds. There are 2,863 schools, 636 fire stations, 592 police stations and 33 emergency operation facilities. With respect to HPL facilities, there are 4,108 dams identified within the region. Of these, 636 of the dams are classified as 'high hazard'. The inventory also includes 2,113 hazardous material sites, 0 military installations and 1 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 225,636.00 (millions of dollars). This inventory includes over 22,023 kilometers of highways, 21,765 bridges, 534,079 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	21,765	14,588.50
	Segments	4,186	82,631.70
	Tunnels	0	0.00
		Subtotal	**97,220.20**
Railways	Bridges	163	24.80
	Facilities	125	280.70
	Segments	3,487	5,851.50
	Tunnels	0	0.00
		Subtotal	**6,157.00**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	2	18.30
	Tunnels	0	0.00
		Subtotal	**18.30**
Bus	Facilities	62	69.60
		Subtotal	**69.60**
Ferry	Facilities	1	1.10
		Subtotal	**1.10**
Port	Facilities	193	416.50
		Subtotal	**416.50**
Airport	Facilities	401	2,251.00
	Runways	440	14,085.50
		Subtotal	**16,336.50**
		Total	**120,219.20**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	5,340.80
	Facilities	187	6,413.90
	Pipelines	0	0.00
		Subtotal	**11,754.70**
Waste Water	Distribution Lines	NA	3,204.50
	Facilities	1,312	90,000.60
	Pipelines	0	0.00
		Subtotal	**93,205.10**
Natural Gas	Distribution Lines	NA	2,136.30
	Facilities	9	10.10
	Pipelines	0	0.00
		Subtotal	**2,146.40**
Oil Systems	Facilities	10	1.00
	Pipelines	0	0.00
		Subtotal	**1.00**
Electrical Power	Facilities	79	8,950.70
		Subtotal	**8,950.70**
Communication	Facilities	397	40.90
		Subtotal	**40.90**
		Total	**116,098.80**

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	2500 year probabilistic statewide
Type of Earthquake	Probabilistic
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	2,500.00
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	8.50
Depth (Km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Building Damage

Building Damage

HAZUS estimates that about 478,451 buildings will be at least moderately damaged. This is over 27.00 % of the total number of buildings in the region. There are an estimated 71,547 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	199	0.02	64	0.02	70	0.02	38	0.03	53	0.07
Commercial	7,639	0.83	3,617	0.98	4,672	1.65	2,821	2.27	1,684	2.35
Education	84	0.01	33	0.01	40	0.01	21	0.02	11	0.01
Government	366	0.04	161	0.04	205	0.07	102	0.08	62	0.09
Industrial	960	0.10	430	0.12	694	0.25	516	0.42	272	0.38
Other Residential	90,849	9.84	52,826	14.33	68,781	24.33	39,342	31.69	20,291	28.3
Religion	597	0.06	253	0.07	273	0.10	173	0.14	111	0.16
Single Family	822,864	89.10	311,150	84.43	208,021	73.57	81,133	65.35	49,064	68.5
Total	923,558		368,535		282,755		124,148		71,548	

Table 5: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	718,348	77.78	265687	72.09	147,744	52.25	38,474	30.99	13,053	18.24
Steel	2,646	0.29	1090	0.30	2,012	0.71	1,563	1.26	858	1.20
Concrete	988	0.11	408	0.11	576	0.20	363	0.29	168	0.23
Precast	1,051	0.11	321	0.09	591	0.21	523	0.42	251	0.35
RM	737	0.08	189	0.05	376	0.13	345	0.28	132	0.18
URM	148,837	16.12	66167	17.95	75,794	26.81	48,884	39.38	39,814	55.65
MH	50,951	5.52	34672	9.41	55,661	19.69	33,997	27.38	17,273	24.14
Total	923,558		368,535		282,755		124,148		71,548	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 23,310 hospital beds available for use. On the day of the earthquake, the model estimates that only 9,802 hospital beds (42.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 54.00% of the beds will be back in service. By 30 days, 75.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	143	56	0	63
Schools	2,863	1,256	105	1,235
EOCs	33	12	5	15
PoliceStations	592	236	41	261
FireStations	636	246	29	275

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	With Functionality > 50 % After Day 7
Highway	Segments	4,186	0	0	4,185	4,185
	Bridges	21,765	1,881	809	19,913	20,213
	Tunnels	0	0	0	0	0
Railways	Segments	3,487	0	0	3,487	3,487
	Bridges	163	4	2	161	161
	Tunnels	0	0	0	0	0
	Facilities	125	56	17	101	102
Light Rail	Segments	2	0	0	2	2
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	62	13	4	57	57
Ferry	Facilities	1	1	1	0	0
Port	Facilities	193	55	35	150	151
Airport	Facilities	401	41	16	378	383
	Runways	440	0	0	440	440

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	187	41	11	145	172
Waste Water	1,312	300	38	853	1,237
Natural Gas	9	5	1	4	6
Oil Systems	10	8	0	2	10
Electrical Power	79	26	4	53	73
Communication	397	114	20	353	374

Table 9 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	267,040	43340	10835
Waste Water	160,224	34278	8569
Natural Gas	106,816	36642	9160
Oil	0	0	0

Table 10: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	2,194,594	98,999	75,116	59,793	35,146	0
Electric Power		668,150	387,416	151,559	35,236	895

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 49 ignitions that will burn about 1.30 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 710 people and burn about 43 (millions of dollars) of building value.

Debris Generation

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 24.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 51.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 960,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates (100,132 households to be displaced due to the earthquake. Of these, 26,833 people (out of a total population of 5,595,211 will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- · Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- · Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- · Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- · Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	293	79	11	22
	Commuting	2	2	3	1
	Educational	0	0	0	0
	Hotels	363	99	15	29
	Industrial	327	89	13	25
	Other-Residential	8,984	2,250	275	528
	Single Family	22,543	5,920	829	1,622
	Total	**32,512**	**8,439**	**1,147**	**2,227**
2 PM	Commercial	18,251	4,952	723	1,407
	Commuting	14	18	31	6
	Educational	4,562	1,293	203	394
	Hotels	70	19	3	6
	Industrial	2,418	660	96	186
	Other-Residential	1,940	496	63	116
	Single Family	4,908	1,332	195	362
	Total	**32,163**	**8,769**	**1,314**	**2,477**
5 PM	Commercial	14,255	3,910	581	1,105
	Commuting	369	469	820	157
	Educational	530	147	23	45
	Hotels	109	30	4	9
	Industrial	1,511	412	60	117
	Other-Residential	3,461	886	114	211
	Single Family	9,091	2,456	361	670
	Total	**29,326**	**8,310**	**1,965**	**2,314**

Economic Loss

The total economic loss estimated for the earthquake is 58,239.26 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 44,277.15 (millions of dollars); 13 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 63 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Loses							
	Wage	0.00	145.07	1,541.96	61.08	73.38	1,821.48
	Capital-Related	0.00	61.90	1,292.57	37.71	23.05	1,415.24
	Rental	726.19	664.95	754.00	22.31	31.68	2,199.13
	Relocation	81.76	19.51	48.19	1.87	11.04	162.38
	Subtotal	**807.95**	**891.43**	**3,636.72**	**122.97**	**139.16**	**5,598.23**
Capital Stock Loses							
	Structural	3,783.26	1,107.64	1,822.62	319.97	350.63	7,384.13
	Non_Structural	12,423.02	4,758.60	4,623.95	971.20	837.81	23,614.57
	Content	3,196.45	1,056.65	2,152.80	627.07	406.87	7,439.84
	Inventory	0.00	0.00	82.47	143.35	14.56	240.38
	Subtotal	**19,402.7**	**6,922.88**	**8,681.83**	**2,061.60**	**1,609.87**	**38,678.91**
	Total	**20,210.6**	**7,814.32**	**12,318.55**	**2,184.56**	**1,749.03**	**44,277.15**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

HAZUS estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 15 presents the results of the region for the given earthquake.

Table 13: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	82,631.69	$0.00	0.00
	Bridges	14,588.53	$618.98	4.24
	Tunnels	0.00	$0.00	0.00
	Subtotal	**97220.20**	**619.00**	
Railways	Segments	5,851.51	$0.00	0.00
	Bridges	24.79	$0.66	2.68
	Tunnels	0.00	$0.00	0.00
	Facilities	280.68	$80.94	28.84
	Subtotal	**6157.00**	**81.60**	
Light Rail	Segments	18.26	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**18.30**	**0.00**	
Bus	Facilities	69.61	$15.60	22.42
	Subtotal	**69.60**	**15.60**	
Ferry	Facilities	1.12	$1.12	100.00
	Subtotal	**1.10**	**1.10**	
Port	Facilities	416.53	$151.34	36.33
	Subtotal	**416.50**	**151.30**	
Airport	Facilities	2,251.01	$340.52	15.13
	Runways	14,085.46	$0.00	0.00
	Subtotal	**16336.50**	**340.50**	
	Total	**120219.20**	**1,209.20**	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	6,413.90	$742.30	11.57
	Distribution	5,340.80	$195.03	3.65
	Subtotal	**11,754.71**	**$937.33**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	90,000.60	$10,195.64	11.33
	Distribution	3,204.50	$154.25	4.81
	Subtotal	**93,205.06**	**$10,349.89**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	10.10	$3.22	31.91
	Distribution	2,136.30	$164.89	7.72
	Subtotal	**2,146.42**	**$168.11**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	1.00	$0.18	17.17
	Subtotal	**1.03**	**$0.18**	
Electrical Power	Facilities	8,950.70	$1,291.87	14.43
	Subtotal	**8,950.70**	**$1,291.87**	
Communication	Facilities	40.90	$5.67	13.88
	Subtotal	**40.89**	**$5.67**	
	Total	**116,098.81**	**$12,753.05**	

Table 15. Indirect Economic Impact with outside aid
(Employment as # of people and Income in millions of $)

	LOSS	Total	%
First Year			
	Employment Impact	3,780,444	219.29
	Income Impact	15,728	19.60
Second Year			
	Employment Impact	2,490,512	144.47
	Income Impact	11,497	14.33
Third Year			
	Employment Impact	57,945	3.36
	Income Impact	2,044	2.55
Fourth Year			
	Employment Impact	3,265	0.19
	Income Impact	(1,261)	-1.57
Fifth Year			
	Employment Impact	186	0.01
	Income Impact	(1,447)	-1.80
Years 6 to 15			
	Employment Impact	9	0.00
	Income Impact	(1,458)	-1.82

Appendix A: County Listing for the Region

Adair,MO

Andrew,MO

Atchison,MO

Audrain,MO

Barry,MO

Barton,MO

Bates,MO

Benton,MO

Bollinger,MO

Boone,MO

Buchanan,MO

Butler,MO

Caldwell,MO

Callaway,MO

Camden,MO

Cape Girardeau,MO

Carroll,MO

Carter,MO

Cass,MO

Cedar,MO

Chariton,MO

Christian,MO

Clark,MO

Clay,MO

Clinton,MO

Cole,MO

Cooper,MO

Crawford,MO

Dade,MO

Dallas,MO

Daviess,MO

Dekalb,MO

Dent,MO

Douglas,MO

Dunklin,MO

Franklin,MO

Gasconade,MO

Gentry,MO

Greene,MO

Grundy,MO

Harrison,MO

Henry,MO

Hickory,MO

Holt,MO

Howard,MO

Howell,MO

Iron,MO

Jackson,MO

Jasper,MO

Jefferson,MO

Johnson,MO

Knox,MO

Laclede,MO

Lafayette,MO

Lawrence,MO

Lewis,MO

Lincoln,MO

Linn,MO

Livingston,MO

McDonald,MO

Macon,MO

Madison,MO

Maries,MO

Marion,MO

Mercer,MO

Miller,MO

Mississippi,MO

Moniteau,MO

Monroe,MO

Montgomery,MO

Morgan,MO

New Madrid,MO

Newton,MO

Nodaway,MO

Oregon,MO

Osage,MO

Ozark,MO

Pemiscot,MO

Perry,MO

Pettis,MO

Phelps,MO

Pike,MO

Platte,MO

Polk,MO

Pulaski,MO

Putnam,MO

Ralls,MO

Randolph,MO

Ray,MO

Reynolds,MO

Ripley,MO

Saint Charles,MO

Saint Clair,MO

Sainte Genevieve,MO

Saint Francois,MO

Saint Louis,MO

Saline,MO

Schuyler,MO

Scotland,MO

Scott,MO

Shannon,MO

Shelby,MO

Stoddard,MO

Stone,MO

Sullivan,MO

Taney,MO

Texas,MO

Vernon,MO

Warren,MO

Washington,MO

Wayne,MO

Webster,MO

Worth,MO

Wright,MO

Saint Louis,MO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Missouri					
	Adair	24,977	947	307	1,255
	Andrew	16,492	759	105	865
	Atchison	6,430	247	77	325
	Audrain	25,853	1,060	307	1,368
	Barry	34,010	1,128	366	1,494
	Barton	12,541	437	102	540
	Bates	16,653	607	134	742
	Benton	17,180	825	150	976
	Bollinger	12,029	411	86	497
	Boone	135,454	6,228	1,684	7,912
	Buchanan	85,998	3,971	1,181	5,152
	Butler	40,867	1,378	504	1,883
	Caldwell	8,969	337	43	381
	Callaway	40,766	1,611	237	1,848
	Camden	37,051	3,077	534	3,612
	Cape Girardeau	68,693	3,261	810	4,071
	Carroll	10,285	417	138	556
	Carter	5,941	213	56	269
	Cass	82,092	4,230	461	4,692
	Cedar	13,733	506	128	635
	Chariton	8,438	370	95	465
	Christian	54,285	2,104	307	2,411
	Clark	7,416	277	54	332
	Clay	184,006	10,567	2,199	12,766
	Clinton	18,979	968	131	1,099
	Cole	71,397	3,334	968	4,302
	Cooper	16,670	626	170	797
	Crawford	22,804	939	177	1,116
	Dade	7,923	279	59	338
	Dallas	15,661	489	115	605
	Daviess	8,016	321	79	400
	Dekalb	11,597	348	75	423
	Dent	14,927	534	162	696
	Douglas	13,084	420	54	475
	Dunklin	33,155	1,015	231	1,247
	Franklin	93,807	4,318	876	5,194
	Gasconade	15,342	683	155	838
	Gentry	6,861	272	79	351
	Greene	240,391	10,545	3,182	13,728
	Grundy	10,432	415	95	510
	Harrison	8,850	369	76	445
	Henry	21,997	914	258	1,173
	Hickory	8,940	371	53	425
	Holt	5,351	219	54	274

Howard	10,212	385	54	439
Howell	37,238	1,141	336	1,477
Iron	10,697	386	69	455
Jackson	654,880	35,387	9,696	45,083
Jasper	104,686	4,034	1,238	5,273
Jefferson	198,099	9,153	1,479	10,632
Johnson	48,258	2,009	803	2,812
Knox	4,361	180	47	227
Laclede	32,513	1,120	388	1,509
Lafayette	32,960	1,497	342	1,840
Lawrence	35,204	1,184	290	1,475
Lewis	10,494	363	59	422
Lincoln	38,944	1,576	209	1,785
Linn	13,754	507	133	641
Livingston	14,558	573	140	714
McDonald	21,681	594	134	729
Macon	15,762	595	114	710
Madison	11,800	426	126	552
Maries	8,903	324	62	387
Marion	28,289	1,239	327	1,567
Mercer	3,757	164	31	196
Miller	23,564	916	180	1,097
Mississippi	13,427	485	81	567
Moniteau	14,827	549	112	661
Monroe	9,311	340	62	403
Montgomery	12,136	549	131	680
Morgan	19,309	1,046	224	1,271
New Madrid	19,760	660	190	850
Newton	52,636	1,897	456	2,353
Nodaway	21,912	864	248	1,112
Oregon	10,344	315	78	394
Osage	13,062	585	200	785
Ozark	9,542	328	71	399
Pemiscot	20,047	611	196	807
Perry	18,132	788	299	1,088
Pettis	39,403	1,590	536	2,127
Phelps	39,825	1,570	346	1,916
Pike	18,351	668	181	850
Platte	73,781	4,330	577	4,908
Polk	26,992	910	236	1,146
Pulaski	41,165	1,745	311	2,056
Putnam	5,223	200	36	236
Ralls	9,626	412	60	473
Randolph	24,663	944	319	1,263
Ray	23,354	1,081	148	1,230
Reynolds	6,689	291	50	341
Ripley	13,509	394	112	506
Saint Charles	283,883	15,141	2,533	17,675
Saint Clair	9,652	359	75	435
Sainte Genevieve	17,842	831	201	1,032
Saint Francois	55,641	2,250	515	2,765

	Saint Louis	1,016,315	59,112	16,127	75,239
	Saline	23,756	1,003	272	1,276
	Schuyler	4,170	146	42	188
	Scotland	4,983	174	60	235
	Scott	40,422	1,521	437	1,958
	Shannon	8,324	262	38	301
	Shelby	6,799	259	74	333
	Stoddard	29,705	1,052	213	1,266
	Stone	28,658	1,241	239	1,480
	Sullivan	7,219	257	61	319
	Taney	39,703	1,588	594	2,182
	Texas	23,003	784	231	1,016
	Vernon	20,454	810	201	1,012
	Warren	24,525	1,167	191	1,358
	Washington	23,344	686	118	804
	Wayne	13,259	503	112	616
	Webster	31,045	1,020	325	1,345
	Worth	2,382	101	20	121
	Wright	17,955	569	154	723
	Saint Louis	348,189	17,827	5,382	23,209
Total State		**5,595,211**	**267,915**	**66,846**	**334,815**
Total Region		**5,595,211**	**267,915**	**66,846**	**334,815**